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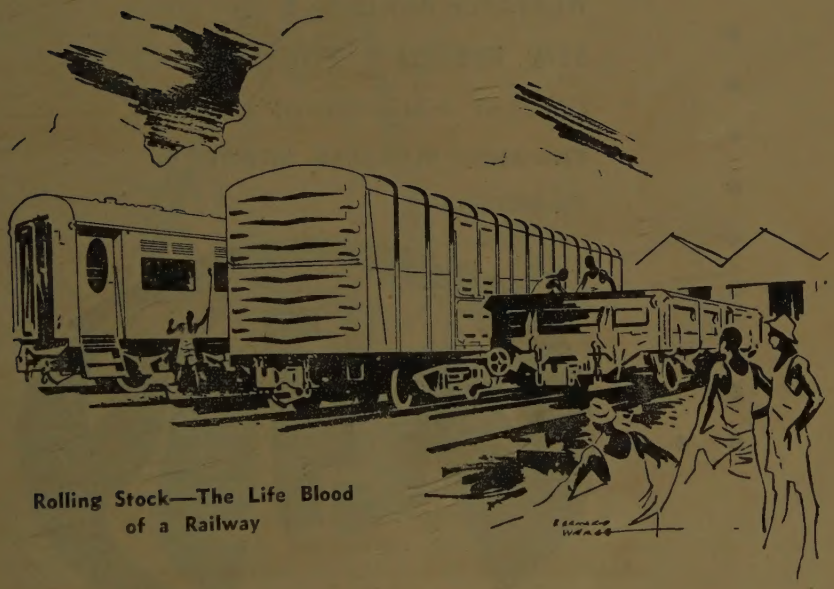

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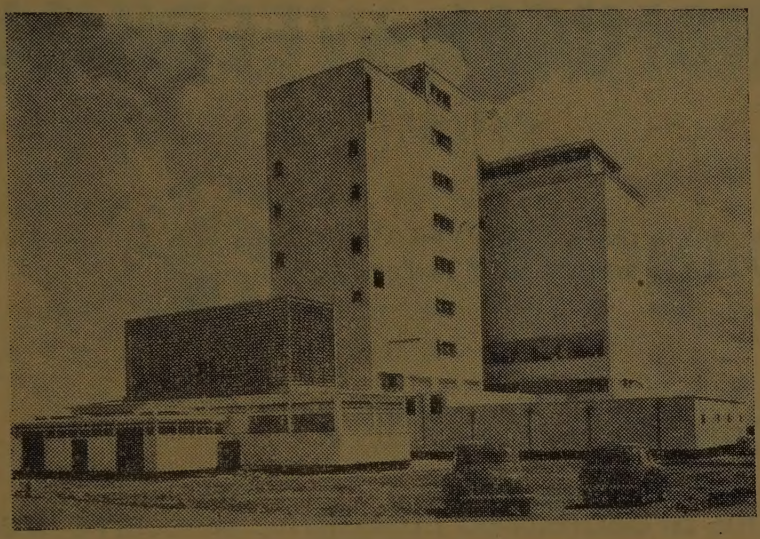

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RESEARCH AND THE TEA INDUSTRY

The record of commodity research stations in bringing scientific principles to bear on agricultural production, particularly in the tropics, is an encouraging one. The tea industry holds a distinctive position in this marriage of science and practice by reason not only of the work that has been carried out but also because of the early start that was made.

The Indian Tea Association founded the Tocklai Experiment Station in the year 1900; the Tea Research Institute of Ceylon followed in 1925, and the Tea Research Institute of East Africa, still in its infancy, was incorporated in 1951 after an embryonic existence since 1949. It is of interest to compare these dates with those of other institutions. The Empire Cotton Growing Corporation came into being in 1921; the Rubber Research Institute of Malaya in 1926.

One consequence of the relatively early start made by the tea industry in the sphere of research was that its research stations have always divided their energies between fundamental and *ad hoc* research. The Imperial Agricultural Conference of 1927 envisaged a chain of research stations concentrating on fundamental problems relating to tropical soils and crops, but economic depression and global war postponed the full development of the idea. Several of these proposed stations have now been established, one of the earliest being the Amani Research Station, which was incorporated in the East African Agriculture and Forestry Research Organization. Tea research stations had therefore to attempt to assess and solve their own basic problems with little or no outside help. The task was and is a formidable one. The major contributions that research has made to the maintenance and progress of the tea industry are instructive, not only as they affect this particular industry but in the wider context of how research benefits an industry and provides an insurance against hard times and difficult circumstances.

The soil reaction values in the acid range that are necessary for successful tea culture are generally found in association with low nutrient status and in India and Ceylon economic crops are only obtainable by the use of fertilizers. Field experiments of a high standard have been a feature of tea research since R. A. Fisher introduced his elegant statistical methods and they have put the manurial aspect of tea cultivation on a firm basis. The Ceylon experiments are approaching the "classical" stage for they have been running continuously since 1930. Their importance was recognized during the war when the stringency with which fertilizers were allocated made their use to the best advantage imperative. The existence of a corpus of accurate information on nutrient needs and responses was the foundation upon which was built a fertilizer rationing scheme that had the support of the Government and the Secretary of State for the Colonies, and which ensured equitable allocations both from primary sources and to individual estates. Similar experiments have been inaugurated in East Africa and it is already becoming evident that the needs here are of a different order from those encountered in India and Ceylon.

The two most important cultural operations in tea production are pruning and plucking. Because the vegetative organs are also the harvested crop a proper balance between what is removed and what is left to maintain the metabolism of the bush is of vital import. Physiological studies of starch storage in the roots under varying cultural and climatic conditions have led to modifications in pruning and plucking techniques that have largely eliminated certain types of dieback which in the early 30's caused severe losses. This work has also clarified the divergence in pruning systems adopted in Assam, where there is a wintering season, and in Ceylon or Africa where no such resting period occurs.

India and Ceylon have far more serious pathological problems than East Africa at the present time, and the work of crop protection has been made possible entirely as a result of scientific research. The most serious of all diseases of tea, the Blister Blight (*Exobasidium vexans*), which reached S. India and Ceylon with unprecedented severity at the end of 1946, has been successfully controlled and crops have since reached record figures in Ceylon. This happy issue affords a good example of team work in research and the value of fundamental research. Mycologist, Physiologist and Chemist

all contributed to the establishment of a fungicidal spraying technique adequate to cope with the problem on an industry-wide scale without deleterious effects on tea manufacture. Should this disease eventually reach Africa, as well it may, despite the restrictions on import of plant material, the experience of India and Ceylon adapted to meet local conditions by the local research station will prove a valuable safeguard to the East African producers. In contrast it is significant that when in the 1880's the coffee mildew (*Hemileia vastatrix*) reached devastating proportions in Ceylon, no research facilities were available and eventually 275,000 acres of coffee, comprising the entire industry, went out of production. In a single decade (1880–90) a quarter of the planting community left the country on this account.

The present successful but costly method of Blister Blight control is not, however, the only research aspect of the problem. Work on improvement in the strains of tea used for commercial planting had been going on in India and Ceylon for some years before Blister Blight became a menace. Although the project has not yet reached a fully commercial scale, the feasibility of selecting resistant types of tea and propagating them vegetatively has been established, and pilot schemes of replanting are in operation.

Research in Ceylon has also been the means of controlling a serious insect pest, the Tea Tortrix (*Homona coffearia*). Though not ubiquitous like Blister Blight it was nevertheless a major nuisance and was gazetted as a scheduled pest under the Plant Protection Ordinance. According to regulations made at one time under this Ordinance the affected leaves had to be picked off at intervals of not more than eight days and their number counted, a procedure which, whilst it kept the pest within definite bounds, was expensive and never showed the least signs of eliminating the trouble. After a number of failures a small wasp (*Macrocentrus homonae*), imported by air from Indonesia, was discovered to be an efficient parasite of the pest, and its natural multiplication has afforded a highly efficient degree of biological control. The Tortrix has long been removed from the schedule of noxious pests.

Research on tea has not been confined to the industry's own research stations. The diagnosis and control of the sulphur deficiency disease, Tea Yellows, the only minor element deficiency so far discovered that affects growth, was an important result of co-operation between the Amani station and the Nyasaland Department of Agriculture. Though the disease is chiefly noticeable in Nyasaland and S. Tanganyika there are indications that all East African soils are low in sulphur status and that continued cropping may enlarge the area of incidence if precautions are not taken. By observation and experiment the Tea Research Institute of East Africa is watching the situation and the first tentative diagnoses outside the well-defined areas mentioned have been made in the Usambaras and Nandi districts.

The contributions to research on the manufacturing processes of tea have been shared by the research institutes, individual firms, and that section of the engineering industry that is devoted to the design of factories and machinery. Year by year, improvements are made though much remains, as always, to be done. Tea manufacture is a batch process not easily conformable to continuous mechanization. Both here and in the field there is scope for close co-operation between the agriculturist, the engineer and the chemist.

The chemist's work starts with the elucidation of the properties of the raw material and continues throughout the changes that take place during manufacture. Both India and Ceylon have made important contributions to the understanding of these processes which are as complex as they are important. There is much more to learn about the chemistry of tea, particularly about the enzymic processes responsible for fermentation, and their relationship to copper availability; in this work East Africa is participating. This fundamental research has its practical application in further *ad hoc* technical research in commercial factories and its importance should not be minimized. India in particular has placed tea producers everywhere in its debt for the light it has shed on the relationship between good quality and the control of bacterial reactions during manufacture.

Within the British Commonwealth there are approximately one and a half million acres producing rather more than a thousand million pounds of manufactured tea. The specialized research activities and the ancillary scientific advisory services of this considerable tropical industry are in the hands of no more than 30 qualified research workers. Their responsibility is great; their opportunities for useful work are manifold and their contribution to the industry's well-being is not inconsiderable.

T. EDEN.

CONFERENCE ON THE MEDICAL, AGRICULTURAL AND VETERINARY ASPECTS OF FOOD PRODUCTION IN EAST AFRICA

Held under the ægis of the Standing Advisory Committee for Medical Research in East Africa, at Makerere College, Kampala, Uganda, 24th to 26th March, 1954

OPENING ADDRESS BY HIS EXCELLENCY THE GOVERNOR OF UGANDA, SIR ANDREW COHEN

It gives me the greatest pleasure to welcome the delegates to this Conference, both those from Uganda and those from the other territories.

There could be no more suitable place for this Conference than Makerere, which has already started to make a valuable contribution to the study of the food and nutrition problems of East Africa and will in the future certainly do so more, with the development of its Agricultural and Veterinary Faculties to match its already developed Medical Faculty. It is very satisfactory that the three Governments have put up large sums of money for the Agricultural Faculty; I hope that the same may happen for the Veterinary Faculty when the College and the departments have decided exactly what is wanted.

There could be no more suitable country than Uganda for holding this Conference. Research is in a flourishing condition here. I need only refer to the work going forward in the country, nearly all of it directly or indirectly bearing on food and nutrition, at the Fisheries, Virus and Social Research Institutes, at Namulonge, in the Agricultural, Veterinary and Medical Departments of the Uganda Government, at Makerere College and under the Medical Research Council.

Those concerned with research in East Africa and those who benefit from it may also congratulate themselves on living at this particular time. A very good start has been made with the building up of research institutes in East Africa—E.A.A.F.R.O., E.A.V.R.O., E.A.T.T.R.R.O., Fisheries, Virus, etc. Much money has been put into plant and buildings and experienced staffs have been built up. The Research Institutes now stand poised to address themselves, with the help and encouragement of the East African Governments and peoples, to the great task of pushing back the frontiers of darkness—perhaps the highest and most exciting task known to man. At this particular moment we are preparing with enthusiasm to welcome the Queen and the Duke of Edinburgh to Uganda. The Duke has shown a special interest in scientific research and when he is here will be meeting the leading research workers who are fortunate enough to live in Uganda. This is not only a great encouragement to all engaged in scientific research of all kinds in this country and all who are interested in research; it also shows the importance attached to research in the highest places.

In the building up of our research institutions we owe a great debt to H.M. Government and to Parliament for the very large grants made to East African research institutions—larger, perhaps, in the aggregate, than those made to any other region of the Colonial Empire. This is a tribute to the energy and initiative of leading scientists in East Africa and also to some leading administrators who have played so vital a part in the organization of research in these countries and to whom I now pay tribute—in particular, Lockhart, Sandford and Scott.

I should like all of you at the opening of this Conference to pay tribute in the usual fashion to H.M. Government and to our friends in the Colonial Office for all they have done to help forward research in East Africa. There is, of course, some cupboard love in this. We are approaching the time in 1956 when new grants will have to be made for the support and development of the various institutions. I hope that those who have come from England and whom we may regard, indirectly at any rate, as representatives of the Colonial Office, will carry back to Mr. Monson, Mr. Lambert and others concerned not only the tribute which I have just paid, but also this message. H.M. Government, with all its world-wide responsibilities throughout the Colonial Empire and the Commonwealth, can in my opinion make no greater contribution, no contribution of more lasting value to the progress of colonial territories and the advancement of their people, than solid material support for the continuance and development of basic

research in all its fields. We in these territories must make our own substantial contribution, as we are already doing and will, I have no doubt, continue to do. But the results of research are long-term and it is, I venture to suggest, legitimate for us to look to the British Government in London for a lead in taking a long-term view of the importance of research. Let us therefore express our gratitude for all that has already been done. Let us record our determination to undertake in East Africa our proper local share of the burden in the future. And let us at the same time hope that we may continue to get the generous support from Home.

Faced as I am this morning with so glittering and varied an array of distinguished experts in so many different fields, drawn from the different institutions in the three territories, I feel to some extent what I think must have been the feeling of the hippopotamus which strayed one night into the gallery of the turbine room at the Owen Falls Power-house. Faced with that shining array of new and most modern electrical machinery it must have felt that, although this machinery lay below its feet, much of it was yet above his head. The hippo turned round and stumbled away into the night. Although I shall not do that, I am glad that it does not fall to me to make a synthesis of all your knowledge and technique. That falls to your President, Sir Bernard Keen, whose speech we are all awaiting with the greatest interest.

One thing I, as an administrator, can say. The shape of things to be in these territories 20, 30 or 50 years ahead, the rate of increase of their wealth and of the rise in the standard of living of the people will be determined by no one more than by you and your colleagues who are engaged in research. In this year of 1954 we can no longer rely, in any of the problems which Government has to face, on hit-or-miss methods or on *ad hoc* solutions. I say again what I have said before, that no modern Colonial Government can hope to be successful in its administration or in guiding development unless it provides to a proper extent for short-, medium- and long-term research. A Government which tries to dispense with or to cut down on research services is like a steersman trying to navigate across the Atlantic without a compass. He may arrive either by strength of character or by good fortune. But is the percentage of probability such that he will do so?

It is our task as administrators to see that scientists have the proper degree of support and the proper conditions in which to work, and above all the proper freedom from interference by Government. For in these countries bureaucratic interference can still do more than in most parts of the world to make or mar a project. We shall do our best to give that support and to help create those conditions, and I am glad to know that research institutions are beginning to develop their own governing bodies to stand up for their interests and at the same time—for every benefit has its price—to see that they fit into our world. The new governing body of the agricultural, forestry, veterinary and fisheries research organizations is a very good example of such a governing body. And may I also pay tribute to the Standing Advisory Committee for Medical Research in East Africa under whose ægis you are now meeting. It is a committee which, in spite of its long-sounding name, has made an excellent and most encouraging practical start. All research which goes forward in these territories must directly or indirectly contribute to the study and advancement of man. The texture of cotton lint studied at Namulonge, the electric current given off by a fish's tail at Jinja, even the habits of rare insects and giant forest hogs in the forests of Bwamba, all are irrelevant except in relation to man and the gradual domination by man of his environment. Here in Uganda, along with other forms of research, we are engaged in or embarking on two sets of studies of paramount importance.

The first is the study of the emergence of the individual in African society, the study of the growth of leaders and of others who have moved forward ahead of their fellows, whether in trade, education, religion, public life or in other ways, and the study of the factors—social, political and economic—which have contributed to the emergence of these individuals. This is a study for the sociologist and for the psychologist. It is a study which will be vital to the future of these territories and vital to the application of the results of nearly all other forms of research.

The other set of studies relates to food and nutrition and is the subject-matter of this Conference. It is the study of the growth and production of food, its preparation and the effect of diet on the mental and physical growth of the individual and of the society in which he lives. This is the concern of every institution

which is represented here to-day and of all of you who are attending this Conference; also, I would venture to say, of the sociologists, who I am surprised to see are not apparently billed to speak at the Conference. For the limitations on action in the field of food and nutrition are not only limitations of climate and soil, nor of man's physical capacity. There are also limitations of custom and tradition which cannot be studied or understood without the help of the sociologist. I hope that a Conference on Food will not again be held in East Africa without the sociologists playing a full part in it.

Here in the field of nutrition, I am firmly convinced, lies one of the principal keys to progress and development in tropical Africa. You, with the combined application of the knowledge and technique which you represent, will sooner or later unlock the door to many things and above all will tap the mental and physical energy of the people which often seems to us at present to be lacking. But that door will never be unlocked, nor will that energy be fully tapped simply by an understanding of the material problems involved. The application of techniques and of scientific discoveries is as important as the techniques and discoveries themselves. Therefore sociologists and probably psychologists must be added to all those who are represented here to-day if you are to reach complete solutions of these complex problems.

I am glad to see that the last paper on your programme is to deal with co-operation between scientific departments on nutrition. I hope that out of this Conference will come, directly or indirectly, combined advice from yourselves as scientists to us who sit in Governments on the right way of organizing that co-operation between scientific departments and the right way of securing the best chance of applying the results of your researches in the field of food and nutrition. Here in Uganda we have a number of institutions and departments working on different aspects of the problem. We have tried to secure co-ordination by setting up a Nutrition Committee under the ægis of Government. Do we need a Nutrition Institute as well as the other research institutions which already exist? I confess that I have already dangled before more than one American foundation a somewhat ambitious project for the comprehensive study of problems of nutrition by doctors, agriculturalists and sociologists. The mills of God grind slowly. It remains to be seen in this case whether they will grind exceeding small.

May I ask you also to pay some attention during your meeting to the problem of the layman, even of the lay administrator, in relation to your fields of research? The programme of the Conference shows what a wide range of studies is going forward in East Africa on the problems of food and nutrition. The average intelligent layman in East Africa has little or no information about the extent and scope of your work. It would be of great value not only to the territories and their Governments but also to all who are interested in these problems, and indeed to the future of research itself, if as a result of this Conference a statement could be drawn up describing in brief terms the problems of food and nutrition which face us, the different forms of research which are being carried out in these problems, the gaps in research which need to be filled, the further work which requires to be done on the lines already covered and the contribution which can be made to the solution of these problems by Governments and the public. I urge all of you not to neglect the importance of explaining yourselves to the public and letting both the public and Governments know in simple terms what you are doing. The field you are discussing in the next three days is an extremely varied and complex one. Much good would be done, and I believe much support obtained for your efforts, if the public could be told generally where we stand in our attack on the problems of food and nutrition and where we ought to be going.

I now declare this Conference open.

PRESIDENTIAL ADDRESS BY SIR BERNARD KEEN, DIRECTOR, E.A.A.F.R.O.

It is indicative of the vigour of the medical profession in East Africa that its members are able to stage yearly a Conference of this nature. It is also indicative of their wide understanding of what is involved that they bring together in one Conference doctors, nutritionists, physiologists, plant breeders, soil scientists, statisticians, sociologists. I would ask my non-medical friends here to reflect on that point. The medical profession is one of the closest corporations in the modern world. Let an unqualified man put up a brass plate and begin to practise and you know what will happen; let an institution, or a Government

department even, advertise a post with conditions and salary unacceptable to the General Medical Council—but, of course, they wouldn't dare. With such a heaven-born, Brahmin-like exclusiveness surrounding them, members of the medical profession could well be excused if, in the words of one of the many quotable passages from that delightful book "England, their England" they "strode about the Green like captains of Spanish galleons, or colonels of Napoleon's light cavalry, seeing no one except each other, but allowing themselves to be seen by everone, chins out, heads high, superbly disdainful, like the camels of Bactria who alone know the hundredth name of God". But, speaking seriously, one cannot fail to be impressed by the full co-operation of the medical authorities with researchers in the other sciences. If you glance down the list of scientists working under the Medical Research Council at Home, you will note, perhaps with surprise, how many of them have no medical qualifications. It is an example of unrestricted co-operation for the good of science and the advancement of knowledge that others would do well to follow. It is admirably exemplified in the list of papers we are to hear and discuss over the next three days. A rough classification shows that they are fairly evenly divided into three categories: medical and nutritional; technical aspects of food production; economic and sociological. Not only that, if you glance down the detailed programme you will find that a thorough mixing has been done; the papers are not grouped in subjects, but follow one another almost, it would seem, at random, as if to emphasize the fact that we are all of us equally concerned with every subject.

It is the function of a presidential address to review the general background against which the Conference is being held and to pick out a few main points which seem specially important or significant to the theme of the Conference. I have selected three, any one of which contains more than sufficient meat to provide a full meal if properly and fully treated. I should exhaust your patience, as well as giving you a bad dose of mental indigestion, if I launched into a full discussion of all aspects of the three main points I have selected. But they are so important that I must say something about each of them. I shall try to select the salient aspects of each and to treat them reasonably lightly. I cannot promise that they will be three perfectly cooked *soufflés* but I will try to ensure they are not three heavy suet puddings.

The three points are: first, co-ordination; second, scientific and technical problems; third, economic and sociological aspects. The second and third, you will notice, cover most of the ground that will be dealt with by the papers before the Conference. The first, co-ordination, ranks almost as a standard item, which everybody—scientists, administrators, politicians and the general public—is always ready to discuss.

Modern civilization has given us so many intellectual tools, so many scientific disciplines and technologies, and even so many ideologies, that the problem of keeping a more or less equal advance on all sectors on such a broad front becomes more and more formidable. That is probably why, among scientists, and in the pages of scientific journals like *Nature*, there are demands from time to time for more general science and less specializing. The arguments are usually variants on the theme that, too often, a specialist is a man who is nearly ignorant of all science, except his own narrow field. The argument goes on to say that more time must be given to the teaching of general science, leaving specializing to come later. It is, as we all know, a very difficult problem. So swift are the advances of science in so many different directions that a course on general science deals largely with matters that have been left so far behind as to have hardly any relevance to the science of to-day. If I may be allowed a personal example, I started life as a physicist, and most of my active research life has been in physics and applied physics. But I frankly say that, except in the very broadest outline, modern physical research into atoms, nuclei and atomic particles is beyond me: and I have the advantage of being a physicist. What then is the position of the chemist, the microbiologist, the entomologist, in trying to keep abreast of physics? Similarly, where is the physicist in his struggle to keep abreast with animal physiology, antibiotics, genetics, and the rest? No, let us face the facts. The corpus of science and technology is nowadays so vast that the attempt to give the budding research worker a broad general grounding of science, adequate enough for him to see how his chosen specialist field is related to that foundation, and sufficiently detailed for him to appreciate other specialist lines with which he will be nevertheless directly concerned, is a task that is to all intents and purposes unachievable. To do it even reasonably well would take so many years that the most

fruitful research period in the scientist's life, that is the 20's and 30's, would be seriously reduced. What we should gain on the swings, we should more than lose on the roundabouts. May I just mention in passing, for it is not part of my theme, the great importance of this earlier period. Nearly all the great discoveries and the striking new ideas come in the early period of a researcher's life. All Newton's genius was concentrated into his early manhood. Occasionally, Rutherfords arise, whose powers of discovery remain unimpaired through late middle age and even beyond. But normally the original work is the product of youth, and the later years are ones of development and consolidation.

But let me get back to my point: the problem of keeping all these separate specialist lines in touch with each other; in other words, the problem of avoiding water-tight compartments. There is a criterion, or a kind of yardstick, that I have found very useful in making up my mind whether a committee or some other form of organization is necessary. This yardstick is based on the fact that in general one can distinguish three broad phases or stages between the brainwave and its absorption into practice. The first stage is fundamental research (or basic research or long-range research) which produces the new idea or the new conception. Then follows the second stage—the technological one. In this stage the new piece of basic research has to be examined in all the permutations and combinations of the environment within which it will operate. To take an obvious example from agricultural research. In the laboratories basic research may have led to new conclusions about the fertility of tropical soils. These must then be tested by field experiments on the various soil types and under the various climatic conditions of East Africa. From this second or technological stage emerges the specific information that is essential before the third stage, introduction to practice, can be done with any certainty.

Organization and committee direction in the first stage, basic research, except in the very broadest and most general terms is quite useless, because the essence of basic research is that one is penetrating into the unknown; you *cannot* organize the unknown. The attempt to do so presupposes an intellectual omniscience that does not exist among us.

But in the second stage, co-ordination of effort and prevention of overlapping are highly desirable. To continue with the example I have just given, we must organize the field experiments to ensure that important soil types will not be overlooked, that the experiments are all comparable among themselves and that, when the results have been accumulated, an overall and balanced review of the results will, automatically, be made. Of course, before we form committees for that second or technological stage, we must be certain that the essential basic information of the first stage has already been obtained. If it hasn't, the committee is just wasting its time. Worse, it may be positively dangerous, because it may be working on preconceived ideas that are not correct; there will be a tendency to interpret the results to fit the thesis, rather than the other way round.

I have said more than enough about co-ordination of effort and overlapping, so let me pass on to my second point.

I wish briefly to review some of the scientific and technical problems facing us in our joint task of improving food production and utilization. These problems, of course, take on the colour of the East African environment, which can be briefly described as a tropical one, modified to varying degrees by altitude. A very short time ago, as human lives go, the population was in equilibrium with its environment. Humans or animals in excess of what the environment could carry were automatically killed off by diseases, famines and tribal warfare. The agricultural system, too, was stable, for it was based on shifting cultivation, in which an area is taken out of bush for a limited period to grow food crops, until its fertility falls off, when it reverts to bush, and an area is opened elsewhere. The entry of the European and the impact of Western civilization have profoundly altered that: human and animal populations are no longer balanced to the land. The Pax Britannica and the introduction of medical and veterinary science have greatly increased the human and animal population. More land is cultivated and for a longer period, so the vicious circle of declining fertility necessitating more and more land under cultivation has gone on until erosion and soil exhaustion have become major problems.

There have, of course, been urgent efforts to devise a better agricultural system which would function at a higher level of fertility and so produce the extra food required. But, most of these efforts were introduced by people

from Home who knew only the practical and technical factors of a temperate-climate agriculture such as those practised in Britain and Western Europe, which are founded on a well-distributed rainfall, the use of leguminous crops and adequate quantities of farmyard manure. The function of farmyard manure, besides providing plant nutrients, is to raise the organic matter or humus content of the soil, because on this largely depends not only the soil fertility, but the proper physical structure or good tilth of the soil itself.

It was natural to assume that this would also apply to tropical soils, especially as tests showed they were markedly deficient in organic matter content. Hence the exhortations to the African to adopt a system of agriculture which made use of farmyard manure, and the condemnations of the practice of burning waste vegetable material, instead of rotting it down for incorporation with the soil. It was so natural to assume that the temperate-climate agricultural system would work if these things were done, that it occurred to nobody to test such an obvious thing. It was only much later that it was realized how utterly different tropical conditions are from those of the temperate zone. The organic matter content of tropical soils is low, not because of bad agricultural practices, but simply because the higher average temperatures cause a rapid oxidation of vegetable organic matter incorporated with the soil down to a low equilibrium value. The structure of tropical soils is looser and more powdery than the crumb-like structure of temperate climate soils, not because of bad agricultural practices, but because of the chemical composition of the clay in the soil, and the absence of organic matter. The right course, therefore, is not to force tropical agriculture into a system that is alien to it, but to develop one that fits the environmental factors that I have just mentioned. This implies a good deal of scientific research into the properties of the soil, both physical and chemical, and, above all, its relations to water. And that brings me to a most important matter. If there is one limiting factor to all forms of East African advancement, whether agricultural or industrial, urban or rural, it is water. We are short of water, both surface and underground. Our rainfall is erratic in amount and distribution. Our overall planning for a better land-use in East Africa must therefore begin with a study of the water supplies, and the provision of adequate catchment areas covered with the right type of vegetation. There are various ways of making this study. Starting with the rainfall, you will hear something in this Conference about the importance of measuring its reliability rather than its actual average amount. But the agriculturist is mainly interested in the rain after it has gone into the soil and this brings one on to the other necessary measurements, such as the amount that runs off along the surface, the amount that stays in the soil, the amount that gets down to the underground water table and the amount that returns to the atmosphere by evaporation from the soil or transpiration from vegetation. Most of these factors require an adequate understanding of soil physics for their proper study and in making a special feature of this subject at E.A.A.F.R.O. I am convinced that we are making a major contribution to East African advancement.

The problem of increasing the fertility of our soils is not one, so far as our present understanding goes, that is likely to be solved by putting back large quantities of organic manure into the soil, because of the excessive and rapid oxidation that I have just mentioned. It may well be that, instead of organic manure, we shall use fertilizers. Here, again, there are marked differences from temperate-climate conditions. In the soils of the temperate zone, nitrogen is the one manure that consistently produces increased yields, but in East Africa the place of nitrogen as an improver of yield seems to be taken by phosphates. I have no time to say anything about the quality of food, although the nutritionists will have a good deal to tell us on that subject. Quality is, of course, all-important. Nevertheless, I would say that the really immediate need in East Africa is for increased quantity of foodstuffs because people are not getting enough bulk to eat.

I have laid stress on the fact that we really know very little about tropical agricultural science, and on the dangers of applying without previous trial the well-proved dictums of temperate-zone agricultural science. However, in spite of these formidable gaps in our knowledge, enough proved technical procedures are available which, if introduced into our agricultural practice, would give marked improvements in output. But, as you all know, these improvements for some reason or other, very rarely take root. In fact, after some considerable experience of agriculture and rural problems under varied agricultural land-use systems in many countries, I am convinced that the difficulty with backward agricultural

areas lies not so much in finding suitable technical improvements. These already exist in quantity, and they are being constantly added to by scientific research. The real difficulty is to introduce these technical improvements without getting their cutting edge, as it were, blunted against the hard core of rights and customs that exists in, and is indeed synonymous with, these backward agricultural systems. Economic and sociological factors are involved, some of which are being dealt with in papers at this Conference; and that brings me to my third point: the economic and sociological factors.

The real controlling factors of the level of agriculture are deep down in the traditional land-use customs, and it is these factors that many of our modern technical improvements kick uselessly against. Not infrequently, reformers are as ignorant of these real controlling factors as was the Sydney financier in his famous exchange of telegrams with his up-country sheep farm manager: "Wool prices rising. Start Shearing". "Can't shear. Busy lambing." "Stop lambing. Start shearing". Incidentally, I wonder how much longer speakers will be able to use that anecdote. Such is the rate of advancement of science that I have every confidence that our physiologists will produce in due course injections and hormones that would enable that third telegram to be literally obeyed!

For the time being, however, the big obstacle to improved agriculture remains. Over much of Africa the cultivator has little personal responsibility for the well-being of the land on which he grows crops. Ownership, if it is thought of at all, exists as a kind of nebulous but complicated joint responsibility of the living and of ancestral spirits. It expresses itself mainly in rights of land usage, and not land ownership, which, in our sense of the word ownership, even community ownership, to say nothing of freehold, scarcely exists. The system, of course, grew up with the shifting cultivation system, and it is now as much an obstacle to agricultural advancement as is shifting cultivation itself.

There is also another kind of land custom closely resembling the Mohammedan one. Here, a land ownership exists, and is accompanied by the deeply engrained custom of equal division of land among the heirs. This leads, as you all know, to successive fragmentation, until an owner possesses a number of scattered pieces, each surrounded by pieces belonging to others. The standard method of dealing with fragmentation when it gets excessive, is by long, tedious and expensive bargaining and by legal processes put into train in an attempt to consolidate the scattered fragments into an equivalent single area. But that, of course, is a Sisyphean task, because as soon as the owner dies, fragmentation of that area begins all over again. The system is much more common in Africa and in East Africa than is generally realized. I saw only a few weeks ago an article in the *East African Standard* commenting on the successful consolidation of fragmented pieces in the Kikuyu Reserve.

The question whether we can alter these land-use systems is at least as important as the problem of introducing technical improvements into the agricultural systems. If permanent alteration for the better cannot be made, the peasant farmer will be imprisoned for ever behind the walls of his own agricultural system. Year by year his numbers will grow and the walls remain. That way lies disaster, because ultimately an agrarian revolution drastically attempts to set matters right. But these vested interests have continued for so long that they are engrained in the very habits of thought of the cultivator. They are, as it were, the immovable boundary conditions around his own social existence, and to remove them is a hopeless task. But can we get round them? In other words, can we circumvent these boundary conditions, as it were; sterilize them, so to speak, or leave them operating precisely as before, but operating harmlessly in a vacuum?

This can be, and, indeed, has been done; not deliberately by carefully calculated and ingenious measures, but in the way in which striking reforms not infrequently happen: almost by accident as a kind of unanticipated by-product of some different objective. I stumbled on this during my period as Scientific Adviser to the Middle East Supply Centre, when I was able to make a study on the spot of agricultural problems in some 14 separate countries. I found a number of agricultural developments, all more or less successful, some exceedingly successful. These developments were exceedingly varied in their inceptions, aims and ideals: Jewish colonies in Palestine, Mussolini's Italian colonies in North Africa, and other examples in Iraq, Cyprus and the Sudan. I am going to select one, namely, the Sudan Plantations Syndicate in the Sudan. Any of the others would have done, because although they all differ widely in their origins,

methods, aims and ideals, they possess one common and vital feature. It is not written into any of their constitutions; it is, as I have said, a kind of accidental by-product, but it got round the biggest obstacle to progress, namely, the throttling effect of the existing forms of land ownership and their associated customs. The device common to all of them was that, in some form or other, the responsibility for the proper use of the land was vested in a corporate body.

The Sudan Plantations Syndicate is of outstanding significance. No less than one million acres in the Sudan Gezira are now prosperous cotton farms. It is a remarkable British achievement. The land on which the Syndicate operates belongs to a number of owners who previously got a very modest return from the land by growing dura, a grain crop, on the precarious and erratic rainfall. The Mohammedan system of inheritance is in vogue, so land becomes fragmented progressively among all the heirs. The story of the Sudan Plantations Syndicate is, briefly, as follows. The Sudan Government took the whole area over on a long lease from the owners. The owners have now an assured and steady rental, so they are at least as well off financially as they were before. The Sudan Government then subleased the area as a unit to the Sudan Plantations Syndicate, which was a British company given certain concessionary rights and duties by the Government. The Syndicate first learned how to grow cotton, pumping up Nile water on to small pilot schemes. Then they divided the land into farms of suitable size to suit the requirements of the irrigation system that the Government was putting in. The boundaries of these farms, of course, bear no relation whatever to the original owners' boundaries. The Syndicate let their farms to tenants, and the first choice has always been given to the owners of the land and their relatives. So you have the amusing but exceedingly significant paradox of people farming as tenants the land of which they are the owners. The tenant's lease gives him all the essential advantages and incentives of private ownership, without the power of subleasing, and it contains a dispossession clause if he doesn't farm properly.

Now observe what happens. In due course, one of the landowners dies. His land boundaries are known, the land is fragmented among all the heirs, but the division is now merely a division on paper: in practice, a division of the *rental* among the heirs. Of course, the boundaries of the new divisions are mapped and registered, and any number of court cases go on about the division, to the lasting benefit of the lawyers. But, nevertheless, so far as practice is concerned, that division is a mere division on a map. It has no effect whatever on the operations of the Syndicate, or on the boundaries of the farms that the Syndicate set up to suit their irrigation ditches. Everything that matters continues unaltered, and so, too, you will note, does the traditional and engrained system of division of land. But it continues now, shorn of its harmful and destructive effects. It reminds one in a sense of some of the picturesque survivals in countries with a long history, like the halting of the Sovereign at Temple Bar, or the searching of the vaults of the Houses of Parliament, that have lost their real early significance.

When I examined all the other systems in the Middle East I found in some form or other the same devices for dodging these limitations.

You will note that the device is one by which the responsibility for the proper use and well-being of the land is vested in a corporate body. The corporate body, unlike the individuals who may compose it, doesn't die; so, control over an area of land, the securing of proper farming practices thereon, in short, care for the well-being of the land, continues unhindered. In the case of the Sudan Plantations Syndicate the corporate body was, of course, the Syndicate itself, and it exercised its functions through its General Manager and its Agricultural Officers.

The corporate body, as you see, is the key to the whole situation. It is something in the nature of what we know as the public utility corporation. The title need not frighten you. There is no political significance in it, and there need be no rigidity in the form of the corporation. Indeed, the Sudan Plantations Syndicate itself has vanished. It was, as I have said, a concessionary company and it operated in partnership with the Sudan Government on the one hand and the tenants on the other. Its concession has now been terminated, and its activities are now absorbed into and carried on by the Sudan Government. The corporation, therefore, is not a rigid affair by any means. It can be a development body set up by the government. It can be within or outside the government. It can be a commission or an ordinary commercial company with statutory

obligations and privileges. It can be a co-operative society of the farmers themselves. It can even be an individual landowner, who has drawn up a trust deed. It can operate on indigenous or foreign capital, or both. It can own the land or lease it. In fact, its constitution can vary within wide limits to suit the conditions and the state of social and economic emergency of the people, provided—and this is essential—that it is also vested with the authority for ensuring the proper use of the land by attaching suitable conditions to its own subleases and to capital loans.

The general principle is so flexible that it applies equally to a vast undertaking like the Sudan Plantations Syndicate, and to the simple conception of group farming by African cultivators. To be really successful the farming system must embrace a crop that brings in a good cash return. The Sudan Plantations Syndicate has cotton. In Uganda, for example, should such a system be introduced, cotton and coffee are already successful cash crops. But we must recognize that this requirement for a good cash crop may seriously reduce the economical financial level of a system where, as is the case over much of Africa, cash crops suitable both for the climate and for the African are not easy to name. But the principle is not altered. It merely means that the public utility corporation, or whatever you like to call it, must operate at a more modest financial level.

I draw your attention to further advantages of the public utility corporation. It can take a broad and overall view. It can integrate the social, economic and technical aspects of the various improvements to be introduced. To return again to the Sudan Plantations Syndicate; that body deals with matters as diverse as the skilled business of marketing the cotton, the introduction of better varieties, the preparation of the cotton for the market, development of the best farming system and crop rotations for cotton, the development of village amenities, the supply of consumer goods to the tenants, and all those welfare activities intended to guide the tenant to a better life and to enable him to make the best social use of his improved financial position. These activities of a public utility corporation are of primary importance to the theme of our Conference.

I believe very strongly that the most important immediate task in East Africa is to put our African farming systems and rural organizations on some sound basis by methods of the kind that I have just mentioned. It is a formidable task. In many places, the land is overcrowded; it is not easy to skim off the surplus people into other activities, or even to put them into unoccupied areas. We are still ignorant of many of the social customs, taboos, and other immovable boundary conditions. It is essential we should know more about these before attempting any scheme that hopes to circumvent them. As I see the task, neither political adjustments nor research into technical improvements will alone solve the problem, important as both of them are. The real problem is to devise means to ensure that the well-being of the land comes first, in all things. It is, I repeat, a formidable task, for the boundary conditions are as near immovable as makes no matter. But, if we can't get round them, sooner or later the crash will come.

I hope this is not too sombre a picture of what is in store for us, so let me conclude on a lighter note by giving you an example of the dodging of apparently insuperable boundary conditions, that appealed to me very much. It will be found in a book called "Boys will be Boys" by Turner, which is an entertaining history of boys' papers, magazines, penny-dreadfuls, and the like. The example comes from the time when adventure stories appeared in weekly instalments. At the end of each instalment the hero was left in a desperate position, so that you felt compelled to buy next week's copy to see how he got out of it. Usually these instalments were written week by week, just in time for the press. On one occasion the author had left Jack, the hero, in an almost impossible situation, bound to a railway line with the train rapidly approaching, surrounded by heaps of explosives with slow fuses all lit, and so on. The next instalment was due, but the author had not turned up in the office. Other members of the paper's staff tried their hand, but were quite unable to get Jack out of his impasse. Meanwhile, the printer was clamouring for copy. Then, in the nick of time the author turned up. He glanced at the end of the last instalment to remind him of how he'd left Jack, and with no knitting of the brows or pause for anxious thought, immediately began to write. The others crowded round to see how he had managed it. And they read, "With one bound Jack was free".

SUMMARIES OF PAPERS

The Calorie and Protein Requirements of Africans in East Africa

By H. C. Trowell

The F.A.O. memorandum (1950) would suggest that "Reference man" (55 kg.) in East Africa requires 2,500–2,700 calories if engaged on *light* physical activity at 20°–30° C.

If hard manual work is undertaken an additional 100–200 calories per hour of work should be added; giving for, say, four hours on the task, a daily total of 2,800–3,500 calories. Since work varies it is impossible to state precisely the calorie requirements and appetite remains by far the best guide.

Tests of mild calorie deficiency are a falling weight, often decreased activity, unsatisfied hunger, and a rising weight if more food is offered; but this deficiency cannot be detected at a *single* clinical examination.

Severe calorie deficiency causes all the signs of starvation and profound lapses in moral conduct. Eventually a few cases develop hunger œdema.

There is probably seasonal calorie deficiency in many areas in East Africa and in towns casual labourers often buy too little food.

The exact protein requirements of an adult man are not known. It has been considered that protein should provide 11 per cent of his calories, if so 69–75 gm. should be taken with 2,500–2,700 calories for a 55 kg. African "Reference man" and 75–95 gm. for 2,800–3,500 calories.

It may well be that the lighter weight of many African men reflects inadequate intake of protein and calories, especially the former, during the period of growth, a matter too long to discuss here, likewise the extra requirements of pregnancy and lactation.

Other authorities suggest that 40–55 gm. of protein may be adequate for a 55-kg. man.

In adults it is uncertain what proportion of protein should be of animal origin.

Uncertainty concerning protein intakes was inevitable as long as the signs of protein deficiency (calories being offered in adequate amounts) were unknown. Kwashiorkor is the only clearly defined condition due to protein deficiency, but much uncertainty exists concerning the signs of a minor deficiency of protein. This disease affects almost exclusively young children and reports are as yet inadequate concerning the signs of acute protein deficiency in adults.

There is almost no knowledge concerning the effects of consuming for long periods diets somewhat inadequate in protein and/or calories, but it is probable that certain disease patterns may emerge.

A brief nutritional survey cannot at present detect calorie deficiency and/or protein deficiency, unless exceptionally severe, and there is great need to elaborate techniques to detect them. Until there is agreement about these tests a nutritional survey is disappointing, for it cannot answer whether the diet is adequate in respect of the two main constituents, those of calories and of protein.

Protein Requirements and their Satisfaction

By R. F. A. Dean

At low levels of total protein intake, such as are found in many under-developed countries, it seems more important to concentrate on improvement of quantity of protein than on improvement of quality.

The requirements for protein are not absolute, but are influenced by many variable factors. The proteins of the food may be subject to subtle alterations, and the utilization of the food may depend on the condition of the recipient. These factors, and many others such as the dislike of new foods, and the wide range of cost in relation to protein contents, must be borne in mind when ways of satisfying protein requirements are being sought.

Some Fertilizer Aspects of Grassland Husbandry in the Kenya Highlands

By H. W. Dougall

Concepts of grassland husbandry similar to those expressed by F.A.O., have been inferred by Troup, parochially, for the Kenya Highlands. He records a need to develop grass-arable systems of agriculture to the full in all climatically suitable districts and would have the balance of all uncultivated land maintained permanently under grass.

The need to develop adaptable techniques for establishing grass and for improving productivity and quality of permanent pastures is emphasized and the use of two major plant nutrients, phosphorus and nitrogen, is discussed in this connexion.

Phosphatic and nitrogenous fertilizers are essential for establishing sown grasses and they can be applied to prepared seed beds effectively by a "placement technique". They will promote increased yields of dry matter, crude protein, lime and phosphorus initially, but their residual effects are slight. Data given in the text demonstrates clearly that the product of a well-managed ley sward is a concentrated food for stock.

Permanent grassland is classified. No essential difference in the management of temporary grassland and of enclosed, productive natural pastures is seen. The use of phosphorus and nitrogen to sustain their productivity and nutrient value is described. The regular use of phosphorus to more than counterbalanced losses inevitably incurred by grazing stock is proposed, and the use of nitrogen in well-defined circumstances to obtain maximum growth at a desired period, is suggested.

Methods for improving worn-out pastures, having soil cultivation and the correction of existing soil-nutrient deficiencies as the underlying theme, are outlined. Improved pastures can be absorbed into an expanding grass-arable farming system.

Proposals for better utilization of rough grazings are made. Paddocking and arranging water supplies are considered necessary whenever economically and climatically possible so that a grading-up process can begin immediately, and treatments such as those proposed can be undertaken at any convenient time subsequently.

The use of urea-molasses mixtures for spraying rough grazings to improve their palatability and nutritive value during periods of relative dryness or drought is considered expedient in the absence of a line of approach that is both feasible and permanent.

Animal as a Convertor of Vegetable Proteins

By R. M. Bredon

The efficiencies of animals as a vegetable protein convertor in the United Kingdom and East Africa were compared. The attempt was made to calculate the efficiency of cattle and pigs kept on the Livestock Experimental Station, Entebbe, as protein and in the case of pigs as non-nitrogenous nutrients convertors.

The availability of proteins from vegetable and animal and their nutritional values were discussed and the points for and against using farm animals as convertors of vegetable proteins were considered.

Some Aspects of the Relationships Between Climate, Soil Type, Nutrient-Status and Other Factors, and Crop Production

By C. H. Gethin Jones

Plant growth depends upon many growth factors, and a combination of certain sets of these factors gives the physiological conditions or the environment governing the growth and distribution of plants. The basis of agronomic investigations is the relationships of selected crop plants to new imposed physiological environments. By selection and breeding, plants are adapted to the local climatic, edaphic and biotic conditions, and again the growth conditions are made more favourable to particular crop plants.

Natural growth factors, such as climate, soil type, vegetation and soil-nutrient status are inter-related. Thus, rainfall, temperature, and in turn vegetation, govern the supply of soil moisture, soil aeration and the nature and rate of soil weathering and hence the kind of soil profile developed.

There can be no absolute scale of soil fertility in terms of listed specific soil properties, but only relative fertility for a particular range of crops suited to the local climatic conditions, and also taking note of the physical, economic and social environment. The temporary fertility of any piece of land can be raised such as by drainage or the addition of fertilizers, or lowered by exhaustive farming.

Crop Production in East Africa

The European Highlands.—The application of farming knowledge gained in Britain helped farming developments in the Highlands, but there were early setbacks due to the lack of basic information on the physiological requirements of crops and stock in new environments. The yields of cereals have been increased by placement applications of phosphatic fertilizers and, at present, there is a steady move towards more mixed farming. There is scope for much greater development of the land resources.

African Lands.—The great need of African lands is to find means of bringing about increased production of crops and animal products so as to give a higher level of nutrition and to raise the general standard of living of an increasing African population. This depends upon the cropping of greater acreages and also by increasing the yields per acre in a system of husbandry that conserves the soil.

The African cultivator has already spread out to occupy and to crop, in varying degrees, most of the better land with an adequate and sufficiently reliable rainfall. Lands which still remain largely undeveloped include regions which are endemic to human and stock diseases, lack adequate permanent water supplies and those which have intractable soils needing mechanical cultivation. Again, more land could be made suitable for cropping by the drainage of swamps and seasonally wettish soils and, locally, by irrigation. There is also some scope for the extension of periodical cropping into selected portions of the present pastoral regions with a lower and less reliable rainfall.

There is also need to increase yields per acre by particular farming techniques which are found applicable to different soils and crops. Widespread field experiments on African lands in the three territories, and also the object-lesson that can be drawn from the European Highlands, show that one treatment that is likely to be effective in rapidly increasing yields will be the use of fertilizers, and more especially phosphates. Should further experimentation confirm that the lack of this latter major nutrient is a widespread limiting growth factor, there will be need for Governments to encourage and to organize this new development along sound lines. East Africa is fortunate in that very extensive supplies of primary mineral phosphates occur in Uganda. With ample hydro-electric power from the nearby Owen Falls, it will be possible to synthesize highly concentrated phosphatic fertilizers and also, if there is shown to be an adequate demand, concentrated nitrogenous fertilizers.

The Microbiology of Soil Nitrate

By E. A. Calder

In vitro experiments on the accumulation of nitrate in a Uganda soil have defined the course of this change more closely and show that nitrate increases in two phases (*a*) during the period when the soil is moist and (*b*) whilst the soil is drying. There is evidence of an overall increase of total soil N of about 5 per cent.

During the moist phase initial rapid increases of NO_3–N from 7 to 17 p.p.m. gives way to a steady condition which is sensitive to aeration and probably reflects a biological equilibrium in the soil.

During the drying phase NO_3–N increases from 17 to 55 p.p.m.

Kjeldahl N shows no evidence of change throughout.

Parallel observations on the soil population reveal characteristic changes related to the moist and the drying phases. Fungal and bacterial peaks occur during the former and there is a strong development of streptomyces during the latter.

Livestock Feeds Into Human Foods

By M. H. French

Against the background of the need to increase the consumption of foods of animal origin in order to supplement present inadequate African diets, the efficiency of producing human foods from animal feedingstuffs, by different types of livestock, is reviewed. Suggestions for improving the output of human food are made, including a stratification of animal industry within East Africa. Reference is made to the need for relating improvements in the potential productivity of livestock to the level of nutrition. The annual loss of grass nutrients due to maturity is considered in connexion with the resulting losses in the output of human foods by ruminants and with the need for introducing methods of fodder conservation. Water, mineral and B vitamin shortages are discussed in relation to the major deficiency, which is an absolute shortage of foodstuffs. The possibility of increasing the output of human food by breeding and genetics is reviewed together with the allied problem of using exotic breeds to improve the productivity of indigenous cattle. The importance of the adaptability of different breeds to local climatic conditions, in the efficiency of feed utilization, is considered with particular reference to their powers of heat tolerance. As an animal matures, it changes in conformation and in the relative proportions of the different organs, joints and tissues. The interplay between nutritional levels and the differential growth gradients are discussed as well as the significance of these reactions on the practical problem of increasing the output and efficiency of human food production by East African stock.

Food Storage Problems in Uganda in Relation to Insect Pests

By A. P. G. Michelmore

Although Uganda is less dependent on stored foodstuffs than countries with a severe dry season, losses to stored products from insect ravages are heavy. Preventive measures are known and could be applied now. The biggest problem is with maize, but other crops, such as rice, sorghum, pulses and root crops, are also affected. The seven basic principles of good storage are not well enough known. They are:—

(1) Thorough drying, for all the pests prefer damp produce.

(2) Rotation of stocks.

(3) Good construction of stores, without which it is impossible to carry out—

(4) complete cleaning of stores; or

(5) control of rats, which encourage insects and heating, as well as doing direct damage;

(6) correct building of stacks; and lastly

(7) the use of insecticides, which is the final answer to insect infestation, but which is only effective if the other measures are also carried out.

Drying of maize presents difficulties in this damp climate, but more could be done by getting the primary producers to stack cobs with perfect sheaths in cribs for a time, while disposing quickly of grain from cobs with broken sheaths. More artificial driers are needed. Combined drying and disinfesting by heat treatment should be tried.

An orderly change from bag to loose bulk storage and transport is suggested as a long-term policy for East Africa as a whole.

To cure the bad conditions in which most Uganda foodstuffs are stored at present, three remedies are needed:—

(1) Reorganized marketing to give all sections of the trade an inducement through profit to improve their methods.

(2) Legislation, supported by a body of inspectors, to enforce proper buildings, vehicles and methods of storing.

(3) Propaganda.

Since so many different interests are involved, collective action is needed, mainly within Uganda, and partly on a wider East African basis.

It is suggested that facilities for large-scale fumigation are needed at the seaports to deal with infested imports and exports, and that a mobile East African fumigation team should be formed for work inland.

The Trypanosomiases—Their Bearing on Native Nutrition

By K. C. Willett

The author, after having given his title, has reached the conclusion that he could make little useful contribution to the Conference by talking on the most direct aspects of the bearing of the trypanosomiases on native nutrition for the reasons of the obviousness of that bearing and the lack of precise data on which to base any accurate conclusions.

Having some data for two groups of Sleeping Sickness Settlements in Tanganyika, he discusses briefly the conflict of requirements in the establishment of these settlements and presents the data on population and cattle densities in these two groups of old-established settlements as they are now.

He then considers the aspect that it has been postulated that native nutrition may bear on the trypanosomiases, and discusses, with a brief historical review and an account of the Tinde Experiment and the work with human volunteers, the relationship between *Trypanosoma rhodesiense* and *Trypanosoma brucei* from which the former has been suggested to have arisen.

Touching on the value of the long-term experiment and the knowledge gained of the Tinde strain of *T. rhodesiense*, he goes on to mention some of the other work which has been carried on concurrently with the main experiment.

In the next section some of the problems of research on trypanosomiasis and some of the deficiencies in knowledge are summarized, and there follows a short discussion of some points in research on the tsetse fly as a vector—not from the point of view of tsetse control—and their relation to epidemiology, with a suggestion of what lines of work may prove profitable, given in terms of their connexion with recent work.

The paper concludes with a brief reference to the Central Trypanosomiasis Research Laboratory, now in process of formation, and the part it may play in co-operation with other research establishments.

The Availability of Sulphur for Both Plants and Animals in East Africa

By R. S. A. Beauchamp

Certain investigations carried out by E.A.F.R.O. are described; the object of these was to find out what factors control and determine the fertility of the East African lakes. It was found that the rate at which essential plant nutrients are brought into solution is the most important factor, and that, among the various plant nutrients, sulphates are very frequently in short supply.

While seeking the reason for this unusual chemical deficiency, it was found that only traces of sulphate occur in the East African streams and rivers. Furthermore, it appears that many soils in Africa may contain too few sulphates for full production. It seems, therefore, that a shortage of sulphur may be a factor of importance to all those engaged in the production of food.

Evidence collected on the growth-rate of fish suggests that this rate, which is unexpectedly low, is determined not so much by the amount of food eaten, as by its quality. Data are put forward which suggest that the quality of this food is probably determined by the amounts of sulphur-containing amino-acids present. However, this point has yet to be proved conclusively by biochemical analysis of these foods.

Fertilizers as a Factor in Food Production in Kenya

By E. Bellis

Years of locust devastation and of incomplete records apart, a significant correlation exists between fertilizer importations into Kenya each year of the period 1922–52, and the corresponding average wheat yield for the Colony. The regression of yield on imports is $Y = 3.07 + 1.424\ X$. Where Y is yield in bags per acre and X is the corresponding fertilizer importation in cwt. per acre.

Calculations based on this regression suggest that the production of food directly attributable to the use of fertilizers has been equivalent to about one-quarter of the Colony's wheat crop. Rates of fertilizer application have tended

to rise and, as yields tend to increase with increasing fertilizer application on responding soils, the proportion of the Colony's food production which is attributable to the use of fertilizer will correspondingly have tended to rise.

Existing fertilizing practice is sub-optimal. Optimum fertilizing practice would produce about 1,000,000 bags of wheat itself and would raise current wheat production from 1,300,000 bags to about 1,900,000 bags annually. Optimum fertilizing practice for European maize would produce about 400,000 bags of maize annually. The food-producing potential of fertilizers in African areas has been less fully examined and only locally are there data available which are adequate for prediction. Nevertheless, over wide areas worth-while yield increases through the use of fertilizers have been recorded, and provided economic conditions remain suitable a big part is foreseen for fertilizers in African food production. Data now available are sufficient for a start to be made this year in the introduction of fertilizers into African food production. The areas in which the introduction is being made are areas totalling about 400 square miles in which detailed examination has shown fertilizer responses to be pronounced and reliable.

The use on wheat of phosphates of relatively high availability dominates fertilizer usage for food production. The practice accords with widespread high yield increases through the use of such phosphates which have been recorded and its comparative unresponsiveness to other fertilizers. The reaction of maize to fertilizers depends greatly on rainfall and differs considerably on different soils. High yield increases have been recorded over wide areas from applications of nitrogenous fertilizers, and of phosphates with relatively high, early. availability. The small amount of data available points to fertilizers having an appreciable effect on crop quality and possibly on nutritional value.

The Role of Modern Insecticides in Food Production in East Africa

By K. S. Hocking

Direct Use—On Food Crops and Stored Food

Insecticides are available that will kill practically all insect pests of growing or stored crops with very small dosages and the problem of their control is the problem of getting the right amount of insecticide in the right place at the right time in the most economical way, without damaging the crop or upsetting the natural biological balance adversely or leaving behind residue toxic to man. Many advances have been made but much basic work remains to be done.

Indirect Use

For example, by eradication of tsetse fly; freeing areas for cattle-rearing.

On a large scale by aerial spraying or by the use of large ground fogging machines. This can be very effective, although never cheap, produces results quickly and does not destroy the game or the bush.

On a smaller scale, residual treatment, of vegetation or tsetse traps, is useful for reducing the fly population to a low level and so preventing contact with man or stock. These methods and insecticidal smokes can also be used to clear up small pockets of fly.

Other cattle pests such as ticks and biting flies can also be dealt with by insecticides.

Medical Use to Protect Agricultural Labour Force

The most important use is in malaria control.

Modern insecticides enable considerable savings in materials and cost to be made in larval control compared with the old oiling methods and they make possible economic aerial applications to large areas. But the main advance in malaria control that these insecticides have made possible is the residual treatment of houses.

Many snags in this method of control have come to light and complete answers to all of them have not yet been found but it is now possible to recommend treatments that should control malaria under most conditions.

Many other disease-carrying arthropods can also be controlled with insecticides.

The Uses of Minerals and Mineral Supplements in the Feeding of Livestock

By D. H. L. Rollinson

The presence of conditions affecting the productivity of the ruminant population and especially of cattle in East Africa is discussed. The eating of earth by both animal and man is concluded to be evidence of a search for elements lacking in the diet or of an unsatisfied craving. Areas in which the reproductive efficiency of cattle is lowered are known and there is presumptive evidence that lack of minerals may underlie the condition. In addition parasitic infection is widespread in the ruminant population.

These conditions can be alleviated by proper supplementation of the diet by mineral elements and an effect has been demonstrated of such supplementation on Zebu cattle. The effect of supplementation is probably composite but includes an increased resistance to nematode infestation. a better food utilization and an increase in appetite. Whether an increase in resistance could also apply to such diseases as East Coast fever and trypanosomiasis is at present largely unknown.

As more is known of the minor elements, so more of their uses can be applied to African conditions, and the possibility of an effect on sulphate metabolism in the Lake Victoria area must be considered. Results indicate that Zebu calves will consume about 10 grammes per day of a brick lick and 30 grammes per day of a supplement in powder form. In addition there appears to be a definite liking for a supplement containing sulphate and the consumption of this has been 73 grammes per day. It appears at present that a mineral supplement consisting essentially of a cobalt salt, and sodium chloride would be cheap and reasonably effective for field use.

Cattle Management Practices and the Study of Animal Behaviour

By K. W. Harker

Some management practices adopted in the districts are discussed in relation to the results of animal behaviour studies and to animal production.

At Entebbe it has been found that under free grazing conditions, two- to three-year-old non-lactating Zebu cattle graze from 6½ to 10½ hours per day, depending on the conditions; ruminate from 4½ to 8½ hours per day, and drink a total of two gallons of water per day. These actions are not evenly distributed over the 24 hours; grazing occurs mainly during daylight, the majority of the rumination is at night and the peak periods of drinking occur during the heat of the day.

Under field conditions, animals spend some parts of their day in a smoke house, *kraal* or small enclosure and are usually taken to a watering place during the late afternoon each day. It is suggested that by imposing these conditions on the animal man may be limiting the animal's production. By limiting the time the animal is allowed on the grazing grounds, man may be limiting the animal's food intake and by limiting the quantity of water consumed man may be limiting the milk production of the lactating animal.

It is suggested also that by limiting the quantity of milk a calf is given the future milk and/or beef production of the animal is restricted. This view is strongly supported by comparisons between Veterinary Department ranged herds and neighbouring herds. As a policy it is suggested that herds should be maintained either for beef or for milk. In the dairy herds only the milk surplus to the minimum requirements of the calf should be used for human consumption.

It is concluded that under free conditions the animal's inherent make-up is a major limiting factor in animal production but that under restricted conditions the limits imposed on the animal's activities are limiting the production of meat and milk. By the study of animal behaviour we hope to assess the effects of management practices on animal production.

Food Crops in the Future

By J. D. Jameson

This paper continues a theme presented recently to the Uganda Society.

Unpredictable developments are briefly exemplified.

The area occupied by banana-eating people is divided between urban and rural populations. Urban populations must have a food which will store, and this would also have a better nutritional status.

Rural populations can choose between perennial crops and annual crops. The latter have a better nutritional status, but would require some organization to condition them and to stabilize their price.

The contribution of different staple foods to the progress of civilization is reviewed. Millet (northern Uganda) and bananas (southern Uganda) are both below the "literacy line".

Progress up the list to maize rice and wheat is considered and discussed.

The Reliability of Rainfall in Relation to Agricultural Development and Population Expansion

By P. Robinson and J. Glover

Water is the most important limiting factor in the expansion of agriculture in East Africa. The native peoples depend on rain-grown crops. Since they already occupy most of the higher rainfall areas, much of their expansion due to increasing population pressure must be into the less-well-watered regions. Not all of these areas of unreliable rainfall are suited to the growth of food crops and the selection of such areas for future development must be done with care. In some the rainfall, although low in amount, will be much more reliable than in others, and advantage of this must be taken. A method of measuring the reliability of rainfall has been developed for the selection of the more suitable regions, and its use should remove some of the uncertainty of planning future expansion.

Since the type of crop which can be grown in the drier areas will be limited, it will not be a simple matter to persuade people to change their diet or adapt themselves to a new environment.

A Preliminary Discussion on Results of a Medical Survey of the Wakara

By W. Laurie

The author directs attention to one aspect of medical surveys, namely the necessity for taking into account parasite loads in individuals. He describes the methods used by East African Medical Survey in its attempt to obtain exact pictures of the states of health and of disease in the peoples of East Africa.

To illustrate how important are survey results in medical planning in East Africa, details are given of the carrying out of one such survey on Ukara Island in Lake Victoria. Reports reaching the mainland from the island suggested that the people were seriously debilitated by disease and by hunger; these reports seemed likely to be true in view of the great population pressure, namely 17,000 people on an island of 30 square miles with much of the island rocky and barren.

A survey was made of a random sample of approximately a quarter of the total population. Records are given of the physical findings and the incidence of stool parasites, urinary parasites and blood-borne parasites, together with hæmoglobin levels and results of serological reactions for syphilis.

The finding showed that in spite of poverty, multiple infections, and overcrowding the people of the island are a happy, well-built population with a high height/weight ratio and a high net reproductive rate.

The answer to this paradox is that the people have evolved a complex, highly efficient system of agriculture described as unique for Africa. Details of this are given.

Finally the author points out the danger of using the results of parasite surveys alone as a method of estimating the disease state of a people.

The Size of the Labour Force in East Africa in Relationship to Agricultural Development

By C. J. Martin

This paper deals with the question of the size of the potential labour force in an underdeveloped country. The labour force is defined in two ways, the first referring to the adult male population 16 years to 45 years of age and the second to the whole population six years and over.

Tables showing the distribution of the population between children and adults in East Africa and the Rhodesias show that nearly half the population are children. Another table shows the distribution of the East African population by five age groups. It is emphasized that with some 1 million adult males employed in work which keeps them from their tribal districts, there may be only left some 2½ million adult males to act as peasant agriculturalists. It is difficult to hazard a guess of the total amount of cultivated land in East African agriculture, but the maximum is considered to be about 100,000 square miles.

With the development of urbanization and specialization of labour, food requirements remain the same, or possibly increase, while the amount of labour available for the production of food and for capital development declines. The question is raised as to whether there is sufficient manpower available to continue current agricultural production and also engage in large-scale development projects.

The paper points out that to place all children in school and encourage women to spend more time in their homes would reduce considerably the manpower potential in East Africa while leaving the number of consumers at its present level. It is thought that for one generation at least it will be necessary for women and children to continue the day-to-day agricultural work, and it is proposed that the men be engaged on plans for improvement.

Principles of Sampling

By W. Brass

This paper gives a brief and simple account of the basic principles of sampling. Sampling is defined as the selection of part of a group to give information about the whole. The concept of the efficiency of sampling and the use of the stardard error as a measure of accuracy are discussed. The advantages of random selection as compared with purposive are stressed and it is pointed out that the belief in the advantages of the latter procedure is largely due to ignorance of modern developments.

The main methods by which sampling efficiency can be increased are considered. These fall into two groups, namely (*a*) those where the variability of the characteristic is reduced with a negligible effect on the cost of sampling, and (*b*) those where a balance must be struck between cost and accuracy. In the first group are the determination of the best type of sampling unit, systematic selection where measurements for contiguous elements are correlated, division of the population into homogeneous strata for separate sampling and the use of supplementary information strongly associated with the characteristic to be estimated. The chief method in the second group is multistage sampling, in which large first-stage units are chosen and smaller second- and higher-stage units within these. This ensures that the elements in the sample are in clumps and the cost of sampling, propaganda, etc., reduced. When more than one characteristic is to be estimated multiphase sampling may be useful. This simply means that some estimates are made from a sub-sample where an unnecessary and costly accuracy would be obtained if the full sample were used.

An indication is given of how sample units should be allocated among the strata, stages, etc., and of the factors which control decisions on the estimating errors at which to aim.

The plan for the survey of African agriculture is a two-stage sampling scheme with households as the final unit and 30 strata per district. The first-stage units are "parishes", artificial groups of 300–500 taxpayers. Two parishes are chosen in each strata and one twenty-fifth of the households in each parish. These households are surveyed for stock and acreages and a sub-sample of one in every three for yields. The sample is designed to give standard errors of the estimates within 5 per cent of the mean for the main stock and crops in each district.

The Effect of Cortisone on Nitrogen Retention in Adult Africans after Protein Deficiency

By E. G. Holmes, E. R. Jones and M. W. Stanier

Following a long series of observations on the nitrogen balance of African adult males who had previously suffered from severe protein deficiency, we have tested the effect of cortisone on the nitrogen metabolism of these people.

Our previous observations had shown that our subjects remained in positive nitrogen balance for very long periods, but did not show weight changes at all corresponding to the calculated tissue retention. In accord with the observations of others, the administration of cortisone reduced the nitrogen storage, and brought about many of the other expected effects. The dose necessary to do this, however, was very large compared to the doses normally used for therapeutic purposes. While there are few data available about the response of normal humans to cortisone, consideration is given to the question as to whether our own, and other, observations, may indicate a hormonal balance in the African different from that obtaining in other races.

Serum Proteins and Related Substances in Adult Malnutrition

By M. W. Stanier

It has already been found that as compared with normal Europeans, the albumin level of apparently normal Africans is somewhat low and the Y-globulin level is high. Further, in apparently normal Africans there is a relation between red-cell count and serum proteins, the albumin increasing and the globulin decreasing with rising red-cell count. The difference in globulin levels occurs mainly in a fraction measured as Y-globulin by electrophoresis and as B-globulin by the chemical method. This fraction has been called "fraction X" and has been shown to be higher in African than in European sera.

Serum proteins, cholinesterase and protein-bound lipoid were estimated in sera from adults with protein-deficiency malnutrition, on admission and during treatment with a high-calorie, high-protein diet. The patients, whether or not they had clinical evidence of liver damage, had low levels of albumin, cholinesterase and protein-bound lipoid, and high levels of globulin. The albumin and cholinesterase rose during treatment. The globulin changes were variable, but occurred mainly in the fraction of the globulin measured as Y-globulin by electrophoresis and as B-globulin chemically. The lower lipoid of patients' sera as compared with normal subjects is due to a lower percentage of lipoid on their lipo-proteins (α and B-globulins) not to a lower concentration of these proteins in the serum.

Sources of Protein for the Prevention and Treatment of Kwashiorkor

By M. D. Thompson

In an area where the dietetic protein is low, kwashiorkor, chiefly in children, is one of the few conditions which is known to be due to protein shortage. The children are under weight with changes in the hair and skin and swelling of the body. Appetite and digestion are impaired and diarrhoea is a frequent complication. A high protein diet is essential to treatment. An increase in general level of protein consumption would probably prevent this disease.

Criteria for Assessing the Value of a Food in Prevention and Treatment of Kwashiorkor

There is evidence that the total protein intake is more important than an excess of any particular amino acid. The factors controlling the ability of any food to provide a high protein intake are:—

(1) Protein content in relation to bulk.
(2) Palatability.
(3) Digestibility.
(4) Cost, supply and storage.
(5) Methods of preparation.

For the initial stages of treatment.

(6) The ease with which food can be given.
(7) The presence of substances likely to provoke diarrhoea must also be considered. Experience gained in treatment enables certain deductions to be drawn about prevention.

Experience of Use of Certain Foods, and Assessment of their Value in Prevention and Treatment

Milk.—Fresh whole milk is adequate, with a simple modification, for the initial treatment of kwashiorkor. For convalescent treatment and prevention it would be excellent apart from the disadvantage of cost, etc.

Dried skim milk is good for initial treatment apart from the tendency to produce diarrhoea. The cause of this is being investigated. Its value in convalescence and prevention is reduced by cost and supply.

Extracted milk protein controls the diarrhoea but because of its low calorie/protein ratio and its cost, is not suitable alone for treatment or prevention.

Substitutes for Milk.—Soya beans are unsuitable for use in initial treatment on account of bulk and taste. They would be adequate for convalescent treatment and prevention. Processing might improve the value of soya but would also increase the cost.

Local beans are unsuitable for initial treatment. In convalescence they need supplementing with less bulky protein-containing food. They would probably be adequate for prevention, especially if supplemented with very small amounts of milk, meat, etc.

Powdered fish and beef are under investigation. They appear to be palatable and easily fed as supplements to more bulky foods. They cannot be made up in fluid form.

Discussion

Cheapness or abundancy of a food are irrelevant if it is ineffective. Foods which can be grown and prepared at home stand the best chance of being properly used. More use could be made of milk. How much could the production be increased and cost reduced? If part of the protein requirements of every child could be supplied from milk or beef and fish the rest could probably be made up from beans without elaborate processing.

Two African Food-producing Schemes

By I. Mann

Earlier destocking schemes aimed at drawing off fair-quality slaughter animals, which could walk to the consuming areas, normally over considerable distances.

Those schemes failed since the African would not sell his best stock, but offered scrub cattle only, which could not reach the market and were not of butchers' quality.

In Kenya an entirely new approach has proved itself.

The abattoir is taken to the beast, and the poorest stock drained off from the overstocked area.

The mechanics of stock purchase and the manufacture and sale of products at the Samburu Field Abattoir are described.

Special reference is made to a highly concentrated beef powder derived from the whole animal excluding only intestines and hoof and horns. This powder is designed as a protein supplement for daily maize meal rations.

Bees are another source of food which can readily be made available to the Africans without further burdening the land. The methods of increasing the yield from bees by the provision of a better hive and proper management are described.

Marketing is improved by establishing rural honey- and wax-refining plants.

Food Taboos in East Africa

By H. Trant

On the basis of over 30 years' practice of medicine and the study of food habits in East and Central Africa, the author discusses the importance of food taboos in the production of malnutrition states in East Africa. She considers this aspect of nutrition studies to have been neglected in much past work and points out that, as a result of food taboos, malnutrition may be found in areas in which there is a seeming sufficiency of good foods.

To illustrate her point, Dr. Trant gives details of food taboos operative among certain

tribes and then discusses the question of differences of taboos for different ages and for the two sexes. She particularly stresses the fact that taboos fall heaviest on women and girls, and especially pregnant women, and illustrates her point by giving details of how limited is the diet of the pregnant African women to whom so many good foods are forbidden on one pretext or another. Lastly the author points out that there is one more inroad upon the few foodstuffs available to the pregnant women, namely the criminal practice of selling the *shamba* products in the neighbouring markets.

She concludes by suggesting some ways in which the evils of food taboos may be tackled.

An addendum is given by Hans Cory, many years Social Anthropologist, Tanganyika Territory. Mr. Cory gives reasons explaining a few of the causes of taboos.

Development of Veterinary Research in Uganda

By J. I. Taylor

Veterinary research in Uganda has been traced from the early days to the present time and it has been shown that as the major epidemic diseases have been controlled, the emphasis has changed from this to conditions influencing the productivity of the animals. There are widespread problems and the need for co-operation among the research groups is stressed.

Combined Cultivation of Field and Human Resources

By A. J. Walker

The state of nutrition in the African agrarian population is a function of population density and group efficiency in food-production practice. Population density in parts of Kenya is computed against the probable measure of the optimum. On the whole, Kenya is essentially underpopulated, provided that more efficient land utilization is possible.

Progress towards more effective land utilization follows acceptance of certain agricultural and veterinary recommendations, which can conflict with the old-established public health concepts. The better conservation of water resources also results in some conflict. It is quite clear that a readjustment of outlook amongst all services must be achieved if the agricultural worker is to be taught to feed himself adequately and to support a non-food-producing urban community.

Public health workers should also be concerned, together with the education and community development services, in cultivating and improving the human resources. To quote some instances, there will have to be a fundamental readjustment of views on the place of the female in society, towards polygamy and towards the custom of the bride price.

The essential factor is to make a study of incentives towards greater output from men. The chief incentive factor is the attitude of the woman, who is in the best position to coerce her menfolk to greater effort. Apart from the urge from greater rewards for labour, other means can be discovered as a result of a closer study of African psychology. A successful trial in the application of the group labour principle is described.

Finally, the question of whether the type of diet consumed can contribute to that state of mind characterized by restlessness, enterprise and initiative, is discussed. It may be that a diet high in animal protein and its first breakdown, "pressor" products, may be better than an equivalent diet from vegetable sources.

In short, the new aim of the public health worker is not to concentrate solely on the prevention of illness and the stifling of epidemics, but to co-operate with others concerned with the improved utilization of natural resources. For himself, his job is to cultivate the human resources towards the promotion of prosperity and stability. His motto should be: "Save the man/hours and the lives will look after themselves".

DISCUSSION

Summary Prepared by Dr. J. N. P. Davies

FIRST SESSION—(78 *Persons Present*)

Papers by Dr. H. C. Trowell and Dr. R. F. A. Dean were discussed together.

Mr. Case (Nairobi) asked if there was definite evidence that kwashiorkor was a disease entirely due to protein deficiency. He queried if a diet in which more than 50 per cent of the calories was provided by maize was necessarily pellagrogenic; he thought a higher figure could be reached without the occurrence of pellagra. He had noted that in Kenya pellagra was only commonly seen in prisons, and he wondered if hard physical work was a precipitating factor. He wondered if in whole maize meal there might not be a toxin which interfered with the nutrition of the patient.

Dr. Trowell said that protein deficiency was the dominating factor, though possibly not the only nutritional factor in kwashiorkor. To give vitamins without increasing the dietary protein did not improve kwashiorkor cases and might even be dangerous. Increasing the dietary proteins resulted in improvement of the patient in all respects. The name "infantile pellagra" should not be used. There was no satisfactory evidence of riboflavin or nicotinic acid deficiency. Maize meal was low in tryptophan and in nicotinic acid and these substances were both involved in complicated metabolic interactions. Whole maize might not be so dangerous as maize meal but the important thing was that nicotinic acid be taken from a variety of foods. He had no information which would make him suppose that if a toxic factor was present in maize meal it would not be present in the whole maize. Recent experience of a Uganda institution had shown that with 60 per cent of the calories coming from maize meal a sharp outbreak of pellagra had occurred.

Mr. Bredon (Entebbe) favoured concentration of policy on improving the quality of protein foodstuffs, and he thought that quantity would follow.

Dr. Dean (Kampala) said that if enough protein was taken in the diet, it did not matter what source it came from, whether animal or vegetable protein. If 80–90 gm. of protein was available in the daily diet there was no danger of protein deficiency.

Professor Frazer (Birmingham) pointed out that most substances necessary for growth and health could be synthesized in the body if the proper starting materials were available. If the diet was low in calories, the basic requisites for synthesis might be lacking, and other substances, not usually regarded as dietary essentials, might now become essential. We needed more information on starting materials from which amino acids and other necessary cell constituents could be built. He drew attention to the findings that, to some children, wheat gluten was a toxic factor. He would be surprised if wheat was unique in this respect. It was a common misconception that all food was good food—some foods might be positively injurious.

Dr. Dean asked if the toxic factor in wheat gluten was destroyed by alkaline hydrolysis. Professor Frazer said it was destroyed by acid hydrolysis, but probably not by peptic or tryptic hydrolysis. Dr. Dean then referred to experiences in Central America, where in some areas the people lived almost entirely on maize, but there was no pellagra. In such areas the maize was steeped in lime water before being eaten and perhaps this process may destroy an injurious factor.

Dr. Mann (Kenya) asked if in the treatment of kwashiorkor there were differences in the speed of recovery, depending on the use of vegetable or animal protein. The feeding of large quantities of wheat flour can cause convulsions in dogs.

Dr. Dean said that kwashiorkor could be cured without any protein from animal sources being used, but that it was not possible to compare speeds of recovery because there was no plant protein preparation yet available of sufficient quality to set up a fair trial.

Miss Canney considered that only a mixed diet of animal and vegetable protein could provide all the necessary biological values. She had studied the incidence of pellagra in Tanganyika prisons; the diet was sometimes of maize alone and sometimes of maize and sorghum, but this did not seem to affect the incidence of pellagra. The important factor had been the groundnut ration; when this was adequate there was no pellagra, but if the ration fell to less than one ounce of groundnuts per person per day then pellagra was

seen. The sorghum supplied had often showed evidence of some change, possibly due to a plant disease, and the maize had sometimes been musty. The old belief that mustiness in maize was a factor in the ætiology of pellagra should not be overlooked.

Professor Fergus Wilson (Makerere) wanted more information about the food consumption of urban labourers. Was there a relationship between the food purchase figures and the amount of money in circulation? He thought the African labourer would change his diet readily enough if he could afford to do so. In Zanzibar during the Ramadhan fasting period it had been shown that there was an expenditure of more than twice the usual monthly amount of money spent on food. The market returns in various districts fluctuated with the cash crop sales. As more money was available the higher-value foods were bought. The major problem was to produce more food and a wider variety of foods. It was a serious danger that there was a serious decline in the variety of foods eaten because of the concentration of the administrations on the production of cash crops. As these crops were pushed the production of the traditional large variety of foods falls off.

Professor Frazer pointed out that it was important to distinguish between exogenous toxic factors, like methionine sulphoximine, resulting from the action of agene on wheat proteins, which can cause convulsions in dogs, as mentioned by Dr. Mann, and toxic agents, such as the gluten factor in coeliac disease, that appear to be natural constituents of food.

Dr. Elmes (Kampala) asked if the occurrence of kwashiorkor could be predicted.

Dr. Dean said that its occurrence in the individual could not be predicted, but that the circumstances in which it would or would not occur could be stated.

Mr. Bellis (Kenya) asked if there was a period in the life of a human being in which reserves of food could be stored in the body as something seemed to be lacking in the balance-sheets presented.

Dr. Dean said that the powers of storage of protein were very limited (some vitamins could be stored), and that more protein was needed at some periods of life, in growth and pregnancy, for example, than at others. The body does, however, seem to be able to adjust, by some unknown mechanisms, to low protein and calorie intakes, indeed to lower levels than previously believed.

Dr. Trowell thought that most African urban labourers adjusted by decreasing their activities. Calories could be stored to some extent as shown by Europeans in high-calorie intakes. More knowledge of African nutrition and nutritional adjustments was urgently needed. The older regimes of fasting and feasting might be good for the economy of the body.

Dr. French (Muguga) said that in pig-feeding the amount of animal protein believed necessary in the pig ration had undergone considerable downward revision. It used to be said that the pig needed 10 per cent of animal protein in the ration. Then war came and it was reduced to 7½ per cent, and then it was found that pigs could do well with no animal protein if the ration provided sufficient vegetable protein, e.g. if 18 per cent of groundnut cake was given no animal protein was needed. If inadequate protein was given in the early life of the pig, the carcass had less muscle meat and more fat. In cattle, too, adequate feeding in early life was essential to economic production. He asked if it was known how far microbiological reactions in the intestine could help in reducing the need for animal protein, and how beneficial was increased fat in the diet of humans.

Professor Frazer said that in man most microbiological action took place in the large intestine, when absorption was normally complete. It was, however, possible that, with certain types of diet and under certain abnormal conditions in the intestine, more extensive microbiological action might occur. Information on this question was at present very incomplete.

Dr. Dean said that microbiological production of amino acids seemed to take place in the ruminant animal only. The amount of fat in the diet was unimportant save in that it provided vitamins and essential fatty acids and that fatty diets were less bulky.

Papers by Mr. Dougall and Mr. Bredon were then read and discussed.

Dr. Walker (Kenya) drew attention to the large amounts of grass grown on black cotton soil which cattle seem not to like to eat. He asked if the urea-molasses mixture had been tried on black cotton soil grass and what was the rationale behind the use of this mixture. Vast amounts of grass in East Africa went to waste, and the question of more effective use of grass was an urgent matter. What could be

done in the drainage of swampy and water-logged ground by the use of the ridge and furrow method successfully used elsewhere?

Mr. Dougall (Kenya) said he had had no experience with black cotton soils: the use of urea-molasses mixtures were under trial in Kenya but no results were available.

Mr. Bellis said that progress was being made in the use of ill-drained bottom lands for arable crops on the ridge-and-furrow system, but that considerable difficulties were encountered.

Mr. Gethin Jones (Muguga) agreed that much good grass was wasted in East Africa, but thought that applying urea-molasses to dried grass on the ground would be wasteful as most would be absorbed in the ground. Could the grass not be cut and then the mixture applied? What nitrogen-fixing legumes were there in East Africa which could be grown with grass?

Professor Fergus Wilson said that grass must assume major importance in the territories; soil fertility was closely related to grass. In the dry weather the grass became lignified and thus of poor nutritive value, and then the rains came, and there was such a growth of young nutritious grass that the cattle population could not cope with it and much was wasted. Grass-drying would seem to be a logical approach. Alternative sources of stock feed were needed. The pre-war practice of sending oil seeds to the United Kingdom to make cake was prejudicial to East Africa. All the oil seeds were needed here. British farmers were looking for increased supplies of cattle food and were drying grass, but the drying process was expensive and the economics of it must be explored. Could "cheap" electricity be the answer?

Dr. French thought that grass-drying should not be the first step. He knew a lot about the use of hay and silage, and the better use of grass by these methods should first be pushed. The trouble with grass-drying was that for much of the time the equipment would not be in use and then everyone would want to use it at the same time. Urea depresses the milk yield if it is given to well-fed cows, but it improved the digestibility of coarse fodder. The consumption of coarse fodder reduced the rate of the passage of the food through the animal with a resulting alteration in the bacterial flora of the rumen. The administration of urea and starches or sugars stimulated the bacteria, improved digestibility and absorption and increased the rate of passage of food.

Mr. Dougall said that in Kenya the labour position would not allow the grass to be cut and then the U/M mixture to be added. It was easier to spray it on the grass. Grass-drying might be worth while in Kenya particularly at certain periods of the year, but even in Britain the economics of grass-drying were obscure. Legumes could be successfully grown at high altitudes, and local legumes could be grown with Kikuyu grass, but the degree of success could not yet be stated.

Dr. Taylor (Entebbe) pointed out that grass must be considered in two conditions: permanent pasture and grass crop or leys. In permanent pasture the limiting factor to the number of cattle, apart from disease, is the quality of grass. This can be improved by better pasture management, chiefly controlled grazing and controlled burning. Grass crop or leys should be regarded as a crop, and a great deal of fundamental work is still required regarding the establishment and maintenance of leys under tropical conditions. In view of the fact that such large areas of land are in African hands it is essential to ensure proper farming methods and to gear our improvements to the level of what can actually be carried out.

Sir Bernard Keen summed up the session. It seemed that what was wanted was more food rather than better quality of foods. The progressive lowering of the minimum needs for protein was good news for agriculturists. As economic and social levels rose, taste prejudices in food tended to disappear, but they were important and must be carefully considered. The work at Amani on cassava had been helped by a tasting committee of Africans and great variations in taste prejudices had been found. As cash crops were introduced the variety of food crops tended to fall; this was regrettable but inevitable, and it was the duty of agriculturists who brought in cash crops to see that variety of food crops was as far as possible retained.

SECOND SESSION (61 *Persons Present*)

Papers by Mr. Gethin Jones and Mr. Calder were discussed together.

Mr. Michelmore (Kawanda) said that the incredible poverty of the soil of the southern two-thirds of the African continent was too little realized. Most was very old infertile plateau, the goodness leached out by the rains

of a vast period of time. The Kenya Highlands, Buganda and some of the alluvial basins of Tanganyika are quite atypical. An expansion of the cultivated area could only go on by a lot of hard work.

Mr. Sherwood (Nairobi) said that this poor infertile land could be brought into use as witness Johannesburg which is fed from this type of land. The difficulty was the provision of the wealth necessary to develop this land. The trouble with Africa was that it was under-populated, and only the best of the land was cultivated.

Professor Beadle (Kampala) discussed the ecology of swamps and said that in Uganda, following the drainage of swamps, the soil became increasingly acid and fertility fell. He considered that the swamps should be regarded as gigantic compost heaps full of necessary nutriments. Drainage would stop the composting progress. The best solution was to use them as they stood either for rice culture or fish culture.

Mr. Gethin Jones said that swamp drainage should be a task for the distant future, needing careful planning and consideration.

Dr. Mann (Kenya) thought there was evidence of widespread phosphorus deficiency in soils and in the animals. If pasture was phosphorus deficient Zebu cattle showed a low blood phosphorus and were in a state of poor nutrition. Phosphate administration benefited pasture herbage and beast. Forty million pounds of bones should be available in Kenya each year, and factories should be set up to make bone fertilizer. What was the best method of administering bone meal?

Mr. Gethin Jones thought that in out-of-the-way areas the best thing was to use bone ash and give it directly to the animal.

Mr. Bellis said that it was difficult to procure bones for processing, as Africans were reluctant to sell them. He felt that there was considerable scope for irrigation in East Africa, particularly in Kenya. Provided that nitrogenous fertilizer was cheap there was an estimated total nitrogen fertilizer requirement of five or six times the amounts of triple superphosphates required. Rainfall was important, as with a rainfall of 30–40 in. ammonium nitrogen was well fixed by soils, but nitrates were not so well utilized.

Professor Frazer asked what was the proportion of soils in East Africa that were intractable and what useful practical steps might be taken to improve production in such areas. He also asked whether there was any relationship between phosphorylation and the nitrogen cycle in soils.

Mr. Gethin Jones said that only about one-fifth of the intractable soils were now cultivated, but with mechanical cultivation probably up to four-fifths could be cultivated. It could not be done with the hoe. We must bring in the plough under carefully controlled conditions. He thought there was scope for irrigation in Tanganyika, but was sceptical of irrigation in Kenya, as the Tana was the only big river but its utilization would be difficult and most expensive. He wished to draw attention to the value of cotton seed ash as a valuable source of phosphate and potassium.

Dr. French then read his paper.

Dr. Dean said that it was too easily taken for granted that animal protein was an essential need of man. Many people were life-long vegetarians and children had locally been reared to two years of age on vegetable protein only and had grown perfectly. The cow could be looked on as a kindly provider of milk, or as an expensive food-processing machine liable to go wrong in the tropics. Direct utilization of vegetable proteins by man might be best if cheap processing methods can be adopted.

Dr. French said there was admittedly a great loss of energy by processing through a cow but until grass-eating became popular among men the cow was at an advantage as she could convert masses of grass herbage not acceptable to man into food which man could use and use readily. Nor must the social importance of animals be overlooked, Africans must be settled with their livestock which were part of their lives. He spoke up for the cow, which had a place in East Africa.

Mr. Bredon said that most African vegetable foodstuffs had a very high carbohydrate and a low protein content, and he wondered if the concentration of protein from such sources would not be a most expensive and wasteful process.

Dr. Dean replied that everywhere the bulk of the protein in the diets was of vegetable origin and in the laboratory plant protein concentrates of up to 55–75 per cent protein had been produced. He wished agriculturists to concentrate on the production of high-protein food plants.

Dr. Welbourn (Kampala) asked how the goat compared with the cow.

Dr. French said that he had little information on the economy of the goat, and he hoped that this would be investigated in the Faculty of Agriculture of Makerere College. The goat was a much-maligned animal. It could linger on and gain a subsistence where no other animal could, and it was then most unjustly blamed for causing infertility for which in reality other animals were responsible.

Professor Frazer said that such a stratification of animal husbandry as Dr. French had proposed would seem to imply the formation of syndicates, such as Sir Bernard Keen had described. He asked whether any such syndicates had been successfully established and also how information on animal husbandry was put across to the African. He mentioned certain instances of successful grass-eating by humans.

Dr. French still doubted if grass-eating would become popular, and said that so far no efforts at stratification such as he advised had yet been made. This stratification would cut across tribal customs, but such would be the benefits that he felt the effort should be made, and the difficulties, he felt sure, could be overcome. He then described the work of veterinary instructors in Kenya.

THIRD SESSION (62 *Persons Present*)

Mr. Michelmore's paper was read and discussed.

Mr. Kerkham (Uganda) said that the basic factor in poor countries was the poor return to the farmer who could not afford expensive measures. He felt that efforts should be made to improve storage on the farm, and that was where most food should be stored. There was no incentive to the farmer to dry maize. A man who stores and dries his produce should receive payment which compensated him for his extra work. The farmers were not interested in propaganda but were interested in cash.

Professor Fergus Wilson said that the loss of germinative seed by pest damage must also be considered, as this was of great importance. Sometimes a second crop had to be grown simply to provide enough seed. Seed-storing by peasants was often difficult and much seed was pest ridden.

Professor Frazer asked what effect efficient storage might have on the amount of food available in East Africa for human consumption, and whether the dangers of toxicity from the use of B.H.C. mixed with grain were adequately safeguarded.

Mr. Michelmore would not care to estimate the pest losses.

Mr. Sherwood said that in various areas in Kenya the crop losses were estimated as from 25–50 per cent.

Mr. Michelmore said that the permitted amounts of the gamma isomer of B.H.C. were 2½ parts per million. Much less was actually used. In Kenya the practice was to use one part per million, so that even if a crop was treated twice the final concentration was under the permitted limit. He pleaded once again for uniform legislation throughout East Africa.

Dr. K. C. Willett's paper was then read and discussed.

Professor Frazer asked if the spread of trypanosomes by biting flies other than tsetse was a question of summation of bites.

Dr. Willett thought that it was a chance result of interrupted feeding of such insects.

Professor Beadle asked what were the insects involved in this mechanical transmission.

Dr. Willett said that tabanids, stomoxys and possibly mosquitoes were involved.

Mr. Calder (Makerere) asked the types of mammals involved in the long-continued transmission series at Tinde.

Dr. Willett said the strain of *Trypanosoma rhodesiense* had been continuously transmitted by sheep-fly-sheep transmission, but parallel transmission had been carried on through antelopes of various types in one experiment, and through monkeys in another. Monkey passage had heightened the virulence to sheep but this diminished after several passages in sheep.

Mr. R. S. A. Beauchamp's paper was then read and discussed.

Mr. Gethin Jones asked if the sulphur content of water had been clearly correlated with the growth of fish.

Mr. Beauchamp said that this had not yet been done, but that where sulphur was present in sufficient amount, as in Lake Rudolf, tilapia reached a weight of 15 lb. as compared with much smaller weights in Lake Victoria. Species of tilapia living in swampy areas where aquatic plants drew up nutriments from the fertile sulphur-containing bottom sediment also grew rapidly to greater sizes.

Mr. Calder asked if crop yields were increased by sulphur treatments.

Dr. Chenery (Kawanda) said there was some evidence coming forward which suggested that sulphur treatment increased yields.

Mr. Bellis confirmed this but thought the effects were slight. There was no data on the relationships of nitrogen to sulphur in East African soils.

FOURTH SESSION (66 *Persons Present*)

Papers by Mr. Jameson and Mr. Bellis were read and discussed.

Mr. Jameson said there was much talk of rice-growing, but an equivalent effort on wheat might be more effective. The problem was what could be got from one acre. Figures of 15 acre-years from Serere in dried produce in three cycles of five years with the use of 2½ tons of farmyard manure every two years were in rotation:—

	lb.
Cotton	8,245
Elusine	18,375
Cotton	6,279
Groundnuts	20,538
Sweet potatoes	20,652
Sorghum	25,957
Cotton	4,749
Grass	—

The very high figures for sorghum were notable. Cotton seed ash was as good a fertilizer as crude cotton seed.

Mr. Randall (Kampala) pointed out that the swamp areas seemingly most suitable for rice production were in the cattle-producing areas.

Mr. Kerkham said that a yield of 4–5 bags per acre of wheat in East Africa compared very poorly with yields of 16 bags per acre in East Anglia. Uganda could probably produce 5,000,000 bags of maize in the near future if the price was right, and might double this in a few years' time without harm to the soil. Where fertile areas were now producing maize in this way, was it wise to go on to fertilizive and expensive investigations of wheat-growing? Was it necessary to step up from a maize economy to a wheat economy to increase the efficiency of the consumers? The real lack was a lack of skill.

Professor Davies (Kampala) did not wish to enter the maize-wheat battle but pointed to instances where an increase in the amount of protein consumed had resulted in a great increase in the physical and mental activities of the people concerned.

Professor Frazer elaborated his arguments on the need for more information on dietary essentials and the range of different alternative starting materials for biosynthesis. He felt that there was still a tendency to take an over-restricted view of the term "dietary essentials"; it must be appreciated that the actual requirements in the diet may vary considerably under different conditions. Choline, for example, only becomes a dietary essential if trans-methylating substances, such as methionine, are not available. He said that most figures of needs tended to be set too high at first and asked whether there was not an optimum level for the application of fertilizers. Mr. Bellis's figures suggested that this was the case.

Mr. Bellis agreed that there were optimum levels.

Sir Bernard Keen pointed out that in the table the yields were charted against the imports of fertilizer into Kenya.

Mr. Robinson (Muguga) doubted if there was a direct correlation between yields and fertilizer imports as so many other factors were involved. He thought that rain would limit wheat production in Uganda at the 5,000-ft. level which did not seem to him to be equivalent to 8,000 ft. in Kenya.

Mr. Jameson said that ecologically these areas were similar.

Mr. Case disliked the idea of too much maize being used. The introduction of maize into Italy was followed by pellagra which remained till wheat replaced maize.

Dr. McFie (Uganda) said that certainly pellagra would follow maize unless a good mixed diet was taken.

Dr. Mann asked if grass-burning was a good or bad practice.

Mr. Jameson thought it was beneficial.

Dr. Chenery said that Dr. Meiklejohn (Soil Microbiologist of Rothamsted) found that total soil nitrogen after burning at Muguga was increased. This is due to the partial sterilization whereby the nitrifiers are killed and do not recover for a long time, thus preventing the loss of nitrogen by washing out of nitrates by rainwater. Crops are better after burning than after straight clearing.

Mr. Hocking's paper was then read and discussed.

Mr. Geering believed that insect pests were responsible for 50 per cent of the stored food lost by deterioration. Was there any information on specific food crop losses?

Mr. Hocking had no information on this point.

Professor Garnham (London) asked about the use, particularly against tsetse fly, of insecticidal bombs dropped from aircraft. Insecticides made labour perhaps too healthy and would lead to huge population increases.

Dr. K. Martin (Nairobi) supported Dr. Garnham. Population pressures were the ethical dilemma of to-day. The reduction in the morbidity and mortality of man was leading to severe problems.

Mr. Hocking had no great hopes of insecticidal bombs, they were expensive and once dropped you were committed to their going off whatever the changes in the local climatic conditions. He thought their use would be uneconomic.

Mr. Randall said that population pressure of stock was causing concern, too.

Professor Davies suggested that, once the pilot experiments were over, the new insecticides might have propaganda value and promote co-operation over wide fields, perhaps obviating some of the problems raised by Drs. Garnham and Martin. Their use made the life of the hut-dweller more comfortable, and their use might be made conditional on local improvement in many respects.

Dr. Mann had noted that dried meat and hides had seemed proof from beetle attack for eight to twelve days after preparation, some protective substances being present of unknown nature. If biltong was put in clean bags in this period, then if wet was avoided and the outside of the bag treated with insecticide then it would keep for 18 months or more.

Mr. Michelmore said that this did not hold for vegetable pests. He thought the Conference was treating the question of population pressure too lightly. Perhaps all medical and educational funds should be transferred to agricultural research. Meanwhile, he could answer Mr. Geering in part on crop losses. In maize the destruction by stem borers might reach 79 per cent in Buganda and from 30–100 per cent in the Eastern Province of Uganda. 3–5 per cent of the food crop entering Kampala was damaged. Co-operation on the work on insecticides in East Africa had been achieved. Uganda workers were studying methods of application and machines. There was need for great caution with some of the chemicals used and he thought there should be uniform legislation in East Africa and a central East African licensing body controlling the use of the more dangerous chemicals. The biological balances were easily upset, and some pests might increase by destruction of their predators. The use of chemicals increased with intensive agriculture.

The papers by Dr. Rollinson and Mr. Harker were then read and discussed.

Mr. Bredon said that again in these papers the Conference had come back to quantity or quality or both.

Mr. Gethin Jones said that cattle licks either contained salts or were composed of unctuous clay.

Dr. Trowell said that unctuous clays in human medicine were used for indigestion and gastro-intestinal troubles: perhaps the cattle were treating themselves. He asked if calves who got less milk were stunted. The correlation between nutrition and helminthic infestation in humans was not clear. Even in heavy ancylostome infections no anæmia might result if the diet was adequate.

Dr. Rollinson said that the inert base he had used was diatomite powder, but this did not appear to influence the uptake so much as the salts in it. Lack of water as well as lack of milk could cause stunting. The relation of diet to parasites was not clear. High carbohydrate low protein diets seemed to predispose to intestinal parasitism. Phenothiazine sometimes retarded cattle through interference with iodine uptake.

Professor Frazer said that some bacteria produced anthelminthic substances and perhaps the salts taken influenced the gut microbiology.

Dr. Taylor said that stunting was important not so much because they could not ultimately come back to expected levels but that they did not mature so quickly and much food was wasted. Stunting was often due to a sudden setback and affected cattle throughout life.

Dr. Mann said that the means of improving Zebu cattle in East Africa lay through better management rather than by crossing with exotic strains. He then outlined the Samburu and the Yatta ranching schemes where the abattoir was taken to the cattle rather than the cattle to the abbatoir.

Mr. Burdin (Kenya) said that there was clear evidence of phosphate deficiency in some areas of Kenya; a survey of blood samples and pasture clippings had shown two-thirds deficient in phosphate, 50 per cent were below 0.2 per cent P_2O_5 and 12 per cent were below 0.1 per cent. Calcium was also low but the calcium/phosphate ratio was normal at 3 : 1. Copper was also low with 25 per cent below 4 parts/million. Two hundred abbatoir liver samples had been studied and had shown evidence of copper deficiency. "Nakuruitis" may be a copper-deficiency disease. He wished to be cautious over sulphur deficiency, a high intake of sulphur and a low molybdenum intake were known to promote a copper deficiency. Sulphur-feeding had no effect on South African stock. We knew of low sulphur levels in the lake water and that cattle selected sulphur preferentially, but we must not assume from this a general deficiency of sulphur. Incidentally he had examined 13 cattle licks and not found copper salts in one of them. Cobalt had not been estimated in the liver samples.

Dr. French came back to Dr. Trowell's questions. Reduced food in the weaning period reduced the stature and the effects varied with the length of the growing period which was short in the pig, long in man. He then illustrated the effects of different scales of feeding on growth in pigs and man. He did not believe that cattle took unctuous clays for relief, they would also eat sand. Such perverted appetite was not necessarily an indication of deficiency but might be a mental release. In the case of goats especially it might be pure devilment.

Mr. Barrett (Makerere) said that there was an outcrop of very pure diatomite at one edge of the Kikuyu Reserve which was sold for consumption over a wide area of the reserve. In South Nyanza the lake shore sand was sent in bags to Kisii in exchange for produce. Milk production, even if intensive, did not necessarily lead to the calves being deprived. It was customary in some areas to milk as the calf sucked, a fair system as the calf being a better milker always got a full share.

Dr. Rollinson said that geophagia was common and widespread, and no one knew what it meant. In Nigeria, calcium lack was a suggested cause. Neither copper nor phosphate had been shown to be deficient in Uganda. Sulphate had been introduced, following Mr. Beauchamp's work, and seems to be much preferred by the cattle. It was to be noted that pigs needed 1 per cent of sulphate in the ration. Copper salts are not used in licks in Uganda as liver samples from Entebbe and from Lango, showed no deficiency nor was there evidence of phosphate deficiency in these areas nor on the farm quoted, where the fertility of the cattle was reduced, was the blood phosphate low. He had not used diatomite alone.

Professor Davies drew attention to the lack of studies of fluctuant and seasonal deficiencies on the life and health of animals. He suspected that the marked seasonal variations in intake might be an important factor in human pathology in Africa.

Mr. Bredon said that studies of phosphate in the Entebbe pasture had shown over one year a steady level of 3–4 per cent, and blood levels in cattle of 4–6 mgm./100 c.c. and there was therefore no evidence of phosphate deficiency.

FIFTH SESSION (55 *Persons Present*)

A paper by Mr. Robinson and Mr. Glover was then read and discussed.

Mr. Davies (Nairobi) was glad to note the increasing attention paid to meteorology and hoped for closer co-operation and progress in the future. There was needed a reorientation of meteorological endeavour from the fields of aviation to agriculture and this must come. Rainfall was a vital matter, but he was not certain if the reliability figures would give all the answers. The records were too short in East Africa to be certain of the statistics. He was uncertain if the reliability maps shown cover the same or different years in the different areas. Annual reliability figures might be of little use. We may have to consider very short periods, down, perhaps, to five-minute periods, as the intensity of the rainfall was important. He would like to see a full-scale investigation of rainfall in East Africa. Though it was an important factor it was only one of the factors that must be considered for each crop. It would be useful if tables for the climatic limits of each crop could be drawn up.

Mr. Robinson thought that calculations of rainfall were a sound basis for further work to decide the best crop areas. He was unable to use the figures for the same years in all areas. He had not used records of less than ten years save in a few instances where the records were scanty and only 6–7 years'

records were available. The distribution was as near normal as could be expected for the seasonal totals in the areas surveyed. The days of rainfall had been recorded but the regular recurrence of rain was more important. The number of days with rainfall corresponded fairly well in the different years. The statistical handling of short-period recordings was very difficult.

The paper by Lt.-Col. Laurie was then read and discussed.

Dr. McFie asked for the diagnosic criteria used in the diagnosis of syphilis.

Col. Laurie said that two positive serological tests were needed in cases who had not got yaws or leprosy.

Professor Fergus Wilson asked if much fish was consumed on Ukara and asked about the protection of crops from cattle.

Col. Laurie said that fish was little consumed as it was marketed; the crops were carefully protected, the cattle were all hand-fed and were even muzzled when led to water.

Mr. Barrett asked if the same high standards of agricultural practice were maintained if the islanders went to live on the mainland.

Col. Laurie said that some islanders had been moved to the mainland some years ago to reduce the population but their settlement coincided with a bad season and all returned.

Mr. Michelmore asked if the weight/height rates could be a fair yardstick in view of tribal variations in physique.

Col. Laurie agreed that it was not an entirely satisfactory yardstick but the physiologists could not give him a better one, and the results of its use were supported by other evidence.

Mr. C. J. Martin (Nairobi) said that the tribal differences had been taken into account.

The papers by Mr. C. J. Martin and Mr. Brass were then read, the latter paper being read by Mr. Currie.

Mr. Jameson reverted to Mr. Robinson's paper in stating his surprise that there was no mention of cyclical variations. In Uganda some areas showed marked cyclic variation, there appeared to be short cycles of rainfall at Entebbe and a longer, 18-year, cycle at Masaka where the yearly rainfall varied in the cycle from 29–49 in. Different months showed great variations. The cycle was present but less marked at Mbarara.

Mr. Robinson thought that more trouble had been made of cycles than they actually justified or were entitled to. We must have records covering longer periods. All East African records were too scanty for dogmatic statements to be made.

Col. Laurie supported Mr. Martin's statement that the women did most of the work in East Africa.

Mr. Martin said that upgrading of women would diminish the labour force available without reducing the number of consumers. He also drew attention to the fact that population increase was not entirely the responsibility of the medical profession but the transportation officials also shared the responsibility.

Mr. Manning (Namulonge) asked if the 20-in. rainfall limit for maize held for soil profiles of widely different soil-water-retaining powers.

Mr. Robinson said that the figures did not apply to all soils. He thought that there was a need to make school vacations coincide with heavy farm work periods.

Mr. Bredon emphasized the need for more statistical help.

Professor Davies supported Mr. Bredon paying tribute to the willing help always extended by the Statistical Department despite the vast amount of time the department had to devote to rather sterile non-scientific tasks. They should press for more adequate statistical cover.

Professor Frazer asked about the effect of vegetation on rainfall and whether much attention had been paid to this subject in the territories. Referring to the papers by Mr. Martin and Mr. Brass, he felt it should be realized that true randomization was not always possible, particularly in medical research, and various devices had to be used to get round this difficulty. There was a dangerous tendency in medical survey work to use successive, rather than simultaneous contrasts. Where a survey was being carried on over a number of years, it was clearly impossible and, indeed, undesirable, to prevent social reforms and improvements from taking place, and these might seriously complicate the interruption of any results observed. This difficulty could be overcome by the use of suitable control areas, so that the changes occurring in the control and experimental area could be kept essentially the same, with the exception of the factor under investigation.

Finally, it might be emphasized yet again that the statistician must be in on the planning of experiments and see for himself how the data is actually collected.

Professor Wilson asked the purpose of the Ukara Survey. He supported Mr. Martin's views on the importance of local labour supply. Policies were sometimes laid down which were physically impossible with the labour supplies available or which resulted in the disruption of the local labour force. He also spoke up for the statistically criticized field officer; his task was not an easy one.

Col. Laurie said the Ukara Survey was carried out at the request of the Tanganyika Government. He had no knowledge of any action resulting from the survey.

Mr. Martin referred to Professor Frazer's last statement and instanced the trouble caused because his department had not been told that part of a crop had been trampled by elephants.

SIXTH SESSION (93 *Persons Present*)

Dr. Margaret Stanier read a paper for Professor Holmes and also her own paper: and these were discussed together.

Dr. Hennessey (Entebbe) asked the nature and value of the high-protein diet.

Dr. Stanier (Makerere) said that it was a 3,000-calorie diet with 150–180 gm. of protein from skim milk and bully beef.

Dr. Walker (Kenya) was interested in the evidence produced of adrenal deficiency as he had long suspected it in Africans and used to treat kwashiorkor with adrenaline, with, he thought, some success. He asked if the drop in the positive balance under cortisone might not be the result of improved absorption as A.C.T.H. had no effect. Does A.C.T.H. stimulate something other than cortisone from the adrenal? Taking the general picture he asked if the physiology of the African might not be of a more juvenile type. He drew the attention of the agriculturalists to cholinesterases, for these were poisoned by parathion, and the low figures might indicate a great susceptibility of Africans to this poison which reinforced Mr. Michelmore's plea that these should only be used by fully trained staff under stringent precautions.

Dr. Stanier said that the effect of cortisone was not to improve nitrogen absorption and she was doubtful if A.C.T.H. acted upon other substances in the cortex. She thought A.C.T.H. failed to act because there was nothing much for it in the adrenal cortex to stimulate.

Professor Frazer said that in certain other conditions low blood cholesterol levels appeared to be associated with secondary insufficiency of sex hormones, adrenal cortical hormones and possibly also vitamin D synthesis. In the observations reported by Miss Stanier it seemed possible that low blood cholesterol might be a key factor. There was increasing evidence to indicate that the blood cholesterol level was related to the overall fat content of the diet so that it would not be surprising if the blood cholesterol level was low in certain African communities.

Professor Davies said he was glad to see support forthcoming for a hypothesis he had enunciated some years ago. Much of the pathology of the African, which differed from that of the European, could be explained on the base of a hormonal imbalance in which the African was subjected to excessive oestrogen activity. The mechanism, it was suggested, lay in the failure of the functually damaged or protein-deficient liver to inactivate oestrogens as was known to occur in men and animals. The concept was probably a little too simple, but evidence was mounting which tended to show that such a hormonal imbalance was widespread and involved many hormones usually metabolized in the liver.

The papers by Dr. Mann and Dr. Margaret Thompson were then read and discussed.

Dr. Dean said that he had never suggested that children should do without milk if it was available but if we wait till there is enough milk many children will die. Soya beans were tried out at Mulago and were processed to get out the essential proteins and they hoped to sell the residue for cash.

Mr. Prentice (Namulonge) asked if some of the high-protein concentrates used for feeding cattle could be used for human consumption, e.g. cotton-seed flour which had been used in the United States of America but was objected to because of its vivid yellow colour.

Dr. Dean said cotton-seed flour for trial was on its way and he would soon be testing it out. If it was useful, samples of the local cotton seed which was readily available would be sent to the United States of America for processing and if this was a success processing here would be tried. Its colour was a difficulty but it could be added to bread.

Dr. Taylor said the Conference had come full circle back to milk again. We should not think of the urban demand but take a wider

viewpoint and think of the rural dwellers who make up the bulk of the population. Mixed farming should be the basis of the economy with plants, animals and man interdependent. The many foodstuffs unsuitable for man, e.g. banana and *matoke* peelings and other such waste products, could be fed to animals. A five-year programme could be drawn up to treble the milk supply based on foods not usable by man.

Dr. Welbourn described her work on infant-feeding in child welfare clinics, it was an attempt to step up the child's intake of food, particularly of protein after the age of six months, using locally available foodstuffs. Skim milk was used but the emphasis was placed on soups of peas and beans which were accepted and used to an appreciable extent. The use of goat's milk was encouraged even if only a little was taken. Dried milks often deteriorated in store and were found to be solid in the container after transit. She felt that diarrhoea was often due to dried milks which had deteriorated.

LAST SESSION (71 *Persons Present*)

Dr. Hope Trant's paper was read by Lt.-Col. Laurie and discussed.

Dr. McFie had been investigating the extent and effect of food taboos in Uganda. Our own food prejudices were very dear and important to us as they were to Africans. Food taboos were being overcome and in many places remained only in the older and wealthier circles. What was sometimes thought to be a taboo was sometimes merely an expression of the fact that certain foods were just not available.

Dr. Soltys (Sukulu) said that many food taboos lingered in Eastern Europe and that mysticism was at the bottom of them.

Dr. Martin (Nairobi) said that there were both selective and restrictive taboos and that Kikuyu women who were pregnant ate little to get a small child but also selected some foods for their believed lactogenic properties.

Dr. Taylor said there were curious taboos about cattle-feeding. It was thought that milk-fed calves were liable to get East Coast fever, whereas the exact opposite is the case.

Professor Garnham said that the inhibitory effect of a milk diet was not exerted against piroplasms.

Mr. Beauchamp said that Batoro boys would not eat fish because of a taboo, even if fish were readily available.

Mr. Calder noted that while European taboos were usually botanical, African taboos were usually directed against animals. He asked how far taboos were reflected in traditional diets and suggested that the dying-out of taboos was a worthwhile study.

The papers by Dr. Taylor and Dr. Walker were then read and discussed.

Dr. Hennessey endorsed fully the deviation in public health policy. The economic factors were all-important. Large capital investment in water supplies was needed, indeed a reorientation of capital investment towards water. If more marginal land was to be cultivated adequate and regular water supplies were needed and more could then be fed. How much capital investment in Kenya was for better water supply?

Dr. Walker said that he had supported such schemes as rice-growing in lake shore areas rather than spend the money for direct medical aid because he was sure that the increased wealth could later support any remedial medical measures.

Professor Davies said that whenever an industrial revolution preceded rather than followed an agrarian and agricultural revolution, trouble was to be expected. Industrialization in Western Europe and America had followed an agricultural revolution. In Russia it was evident that the agricultural developments had not kept pace with industrialization. He was concerned that in East Africa industrialization was being hurried on in advance of the agricultural revolution, which must come first.

Mr. Randall expressed appreciation of the work of the Uganda Geological Department in improving water supplies by building hundreds of dams. The livestock industry had benefited enormously by increased grazing and consequent increased production while disease control was facilitated. In the West Nile, battle with the Medical Department was still going on because of fear of schistosomiasis if dams were built.

Dr. Hennessey said he appreciated the increased use of water by stock and the attention paid to water supplies, but was enough being done?

Dr. Willet said water was of paramount importance in East Africa where there were enormous differences in water distribution. Conservation was imperative, for gross waste was visible everywhere. Streams dry one minute were raging torrents a few hours later;

all this water was wasted. He drew attention to the fact that Tanganyika had a Department of Water Development.

Dr. Dean spoke about the urgent need for bringing Africans into the research field. As education developed he hoped they would soon be playing their part in research and development for only in this way could the suspicion that we were inforcing purely Western ideas be overcome.

SUMMING-UP

By Professor A. C. Frazer

Professor Frazer then summed up the Conference, saying how much he had enjoyed every part of the meeting and how he had appreciated the wide range of subjects covered in the papers and discussions. All present would have appreciated how worth while such a Conference was. There were four parts to the discussion—soil, plants, animals and man. He would consider man first, as the Conference had been inaugurated by the Medical Advisory Committee. All work, as His Excellency had said, should be directed to the improvement of man, and even those who gloried that their research had produced information of no practical use or significance to man were still, in fact, dependent upon the appreciation of the subtleties of their work by human brains. The question of needs from the nutritional point of view was often misleading. Dietary essentials must be provided, but the differentiation between essentials and non-essentials was often over-simplified. There were certain molecular groupings that could not be synthesized in the body and it was clearly necessary that these should be included in the diet, but a very large amount of the body structure could, in fact, be built up from quite simple units. It was clear, however, that if there was an overall shortage of food materials, priorities must arise with regard to the raw materials for biosynthesis, and the question of alternative pathways for these synthetic processes may become important. Thus, the questions of quantity and quality of the diet are so closely interwoven that one cannot usefully consider the one without the other. There was clear evidence in the African situation, as Drs. Trowell and Dean had shown, that there was an overall protein deficiency which was quite as important as any specific amino acid deficiency. It seemed clear that we should try to get all the protein we can into the African diet. Drs. Thompson and Stanier had considered the intake and utilization of protein. As to the nutritional status of the African, there was no reason to think that protein was the only deficiency, but this had been clearly proved, and if it was corrected other deficiencies might reveal themselves and these could be dealt with later. There could be no reason for delaying the correction of the protein deficiency that was known to exist in many African communities. From the medical point of view, a vicious circle tended to be set up, since production of any sort, including food production, needs work, and this is dependent on health; good nutrition may play its part in resistance to disease and there was an obvious advantage in controlling major diseases to encourage production. The problem of over-population was serious, but he was on the side of Mr. Martin in holding East Africa to be under-populated. This question is of course, a relative one and there must be an optimum level of population for any given area. There is some reason to believe that as health, wealth, social improvement and education increase there is a tendency for the birth-rate to decrease *pari passu* with the decline in infant mortality. This would certainly appear to have been the case in England during the last 100 years. In any case, whatever may be the policy with regard to the application of public health measures, there cannot be any doubt that medical research into health and disease, in all its aspects, must be pursued wherever opportunity offers, with unabated vigour.

As to soils in East Africa, the key problem appeared to be water. Co-ordination and research on rainfall and water utilization were of the highest importance. There was positive evidence of mineral deficiencies of interest to veterinarians and agriculturalists, and possibly to physicians, but the use of the word "deficiency" in this context was open to question. Because the level of certain minerals happened to be less in East African soils than in those found in certain other parts of the world, this did not necessarily mean that the soil was deficient, either from the agriculture, veterinary, or medical point of view. The question of soil nitrogen was clearly important

and offered a wide field for research. It seemed that tropical soils do not fix, hold, or retain nitrogen adequately. Supplements could obviate the inherent inadequacies of nitrogen, phosphorus, and possibly sulphur. Increased acreage depended on many factors—on better water distribution, trypanosomiasis control and other large-scale measures. New land should be put to new and better use.

The plant produce of East Africa was of two types—subsistence crops, by which was meant crops that were eaten, and cash crops, the return for which came back to the producer in other ways. Cash crops were useful, but dangerous, as the desire to make money might cause too much land to be deviated from the production of subsistence crops. There is room for the development of better types of subsistence crops. Changes in the dietary staples were possible and desirable where locally used staples were unsuitable. One must presume that the staple diet of any community was originally decided mainly on a basis of availability and cheapness. It so happens that, in the course of time, the accepted staple diet for a particular community may become less available and more expensive, but the tradition and habit of the people may cause them to continue with the use of this staple, to their economic and nutritional detriment.

Many areas were unsuitable for hand tilling and there was scope for mechanization, and where the land was otherwise intractable, this was clearly advantageous. The replacement of hand tilling by mechanization in more fertile areas, however, had its dangers, since it sometimes resulted in a restriction of the varieties of food produced, as compared with hand-tillage methods. A good deal had been said at the Conference with regard to alleged differences between animal and plant proteins; available evidence supports the view that in any given plant protein, the amino acid pattern may be somewhat unbalanced for animal nutrition; this is obviously overcome by the conversion of plant to animal proteins, but can also be corrected by the careful selection of different plant proteins. A planned variety of vegetable food has, therefore, considerable nutritional importance. Storage was a vital matter, pest control was essential and would contribute greatly to nutritional improvement. There was a danger that food crops might be chosen for a number of apparently good reasons, such as drought resistance, good storage properties, or resistance to pests, but without reference to nutritional value. What is important in human nutrition is not just what is grown, or what is harvested, or what is sold, or even what is eaten—but what is actually utilized in the human body.

In the discussion on grass, the importance had been emphasized of good husbandry, the control of grass-burning, the elimination of waste through cutting at the appropriate time, and the care of animals according to their eating habits.

As to animals, the importance of deviating them on to non-human foods had been noted, as had the improvement of such animals as the goat. Adequate feeding and management were necessary to build up and maintain the health of these animals. Animals were good things to have around and they were appreciated by the African. It was possible that stock and crop cultivation had to be considered more separately than was usual in the United Kingdom and elsewhere. One had to consider, not so much that meat was essential in the diet, but that animals were an essential part of the general economy of the country. Dr. French had advised us to concentrate on indigenous stock, and good husbandry was the key to greater production. Genetic factors were of less importance than better husbandry. The important question of the stratification of the animal industry should be thoroughly explored. Dr. Mann had shown a way to obtain more protein by making better use of animals that are unable to travel large distances to central abattoirs. His development of the mobile abattoir, as a means of tapping large meat resources among the pastoral tribes, that are at present largely lost, is a startling and important contribution to the problem of food production and utilization in East Africa. On the question of distribution of food between man and animals, it would seem reasonable to work on the principle that if man can make good use of plant food he should do so, but if he cannot utilize it effectively, it should go to animals.

Professor Frazer drew three main conclusions from the Conference. Firstly, that a very great improvement in nutrition could be expected if the best use was made by better husbandry, better use of soil, water, crops and animals, and more effective distribution of existing things. Research, education and administration should be aware of this. Secondly, close co-ordination between medicine

and the other bodies concerned with the opening up of new land was needed. New land for food production could be got by disease control. The vicious circle could be broken, and more efficient and happy people would result from better feeding. There should be a closer combination of ideas for improvements in the agricultural, veterinary and medical fields. It is important to consider and record the number of mouths filled and bodies nourished, as well as the crop yields per acre. It would be well if there was a definite policy with regard to cash crops, to prevent undue deviation of production into non-nutritional channels. Thirdly, it is clear that scientific workers must co-operate with administrators, sociologists and educationalists in the best use of natural resources. Education must be the basis upon which progress is made. The application of nutritional knowledge to the welfare of the people is fundamentally dependent upon the education of those people—the women and children, just as much as the men—as only by this means can the evil effects of bad traditions, taboos and superstition be effectively overcome.

He finished by thanking the authorities of Makerere College for the use of the facilities put at the disposal of the Conference.

REVIEW.

NYUKI NI MALI (BEES ARE WEALTH), by Dr. I. Mann. Illustrated by Erica Mann. Pub. Dept. of Veterinary Services, Kenya (Eagle Press, Nairobi), pp. 109, many illustrations and plan.

The need for a simple but adequate book on bee-keeping in Kenya has long been felt, particularly as all Africans are potential bee-keepers, though few follow anything other than the old, wasteful traditional methods. This book will, I am sure, fill this need for a long time to come. The simple details on all subjects are such as to stimulate the interest in bees which can be satisfied with the simple and inexpensive methods for keeping bees so thoroughly described in this book.

The Director of Veterinary Services has written a short but wise foreword, pointing out that the bee alone is capable of increasing food supplies and cash income without imposing any additional burden on the land. The book starts with an introduction stating the aim of the work to show how, by the use of better equipment, bee-farming may become a profitable and pleasant undertaking. The life and work in a beehive is described in a generalized manner, the chapter on the beehive describes the split-log hive used on Mt. Meru, suggests simple improvements in the traditional log hives, and describes simple box and petrol tin hives which have been shown to be effective. Movable comb hives are described for keepers who have already acquired skill in the handling of bees. The equipment necessary is described and illustrated Methods of hanging and distributing hives, of handling bees, work with bees such as securing and establishing swarms are all described. The chapters on honey and wax and how to produce these in good quality are of real interest and value. It is certain that the suggestions contained in this chapter could go a long way to increase and improve production to the considerable benefit of African bee-keepers. The book ends with a description of a honey- and wax-refining and packing plant suitable for African areas, similar to several which are already, I understand, operating successfully. This is accompanied by a loose sheet of professionally drawn plans of such a plant.

The book admirably fulfils the aim of showing how great improvements can be made quite simply and I hope that it will result in greater interest in bees in this country and more success with them. This, indeed, is certain, if the simple principles are carefully followed and put into practice.

R. Le P.

A SIMPLE AND INEXPENSIVE INSECTICIDE DUSTER

By G. Swaine, Department of Agriculture, Tanganyika

(*Received for publication on 2nd March*, 1954)

The apparatus described in this paper was originally designed for use by African peasant farmers although it may have application elsewhere, e.g. in market gardening. The main requirements of the duster were that it should be cheap, efficient and robust and that it could be made or repaired with the minimum of technical knowledge from materials available locally.

Construction

The body of the duster (Fig. 1) is made from a cylindrical tin completely closed at one end and with a tightly fitting push-on lid at the other. This tin is cut around the middle so as to give two open-ended tins of equal size, the sharp edges being turned over to form a lip. A recurved delivery tube is soldered on to the push-on lid, dust pasing through a perforated thimble inside the lid. Handles are soldered to the closed ends of the two tins which are then linked together by a sleeve of rubber, retained in position if necessary by two wire rings. For crops of medium height, such as cotton, the small conical nozzle (Fig. 1) has been found suitable. With low crops, e.g. beans and young maize, the longer attachment (Fig. 2) is preferred. The nozzles are interchangeable and can be turned to any direction desired.

Fig. 1—Duster with short nozzle

Costs

The tin forming the main body of the duster (6 in. in diameter and 8 in. long) is obtainable locally for E.A. Sh. 1/60. A local tinsmith charges Sh. 2 for the manufacture and fitting

Fig. 2—Duster with long nozzle

of the short nozzle version, or Sh. 3 for the longer nozzle model. Rubber sleeves can be cut from discarded lorry inner tubes, in this particular case size 7–50 x 20; should the purchase of new tubes be necessary the cost is approximately Sh. 1/50 per sleeve. The price of the wire is negligible; the complete duster is therefore made for Sh. 5 or Sh. 6 according to model.

Use

The duster is filled to the three-quarter-way mark with approximately 4½ lb. of talc-base insecticide. When replacing the push-on lid it is found convenient to have the top and bottom handles in the same line. The duster is held in the same manner as a concertina and dust is puffed out by a bending action coming from

Fig. 3—Duster being used on young maize

the wrists rather than by a direct squeeze using the entire arm. The quantity of dust ejected is controlled by the force applied and by the inclination of the duster to the ground. As both hands are employed both the volume and direction of dust ejected at each puff are under excellent control. A gentle lowering of the nozzle end and elevation of the opposite end is all that is necessary to maintain the evenness of application as the quantity of insecticide in the duster diminishes. An illustration of the duster in use on maize is given in Fig. 3.

SUMMARY

A description is given of a simple and inexpensive insecticide duster suitable for use on smallholdings. The duster has been so designed that it can be made with the minimum of technical knowledge from easily obtained materials. Interchangeable nozzles permit use of the duster in low or medium height crops.

BOOK REVIEW

A REPORT ON CACAO RESEARCH, 1945–51, published by the Imperial College of Tropical Agriculture, Trinidad, B.W.I., and the Cocoa, Chocolate and Confectionery Alliance, Ltd., 11 Green Street, London, W.1 (1953), price Sh. 25.

The original cacao research scheme for the West Indies was started in 1930, at the Imperial College of Tropical Agriculture, and was expanded in 1947 into the present scheme, which is financed by the Colonial Development and Welfare Scheme and the Cocoa, Chocolate and Confectionery Alliance, Ltd. Between 1932 and 1944 eleven progress reports were published, and this comprehensive report for the period 1945–51 summarizes the work carried out since the 11th report was published. Throughout the 21 years for which reports have been published, the results show more and more clearly the extreme complexity of the overall problem. In one of his contributions to the present report, Professor Hardy suggests that the basic reason for deterioration in cacao production in Trinidad may be the ecological change from natural forest to planted cacao. He says: "Deterioration begins immediately the land is exposed and continues at a rapid rate. The planter attempts to retard these destructive changes by providing ground shade of various kinds (bananas, tannia, cassava) as soon as the forest is felled, but he seldom applies the "shelterwood" system that has been found by silviculturists to be essential to the natural regeneration of forest in Trinidad". If this is true when land under natural forest is cleared and planted with cacao, it is obvious that much more difficulty will be experienced when old cacao land is replanted. Nutritional deficiencies, virus and fungus diseases, insect pests, and soil deterioration are only to be expected if the plant is not growing in its natural environment, and it is only by study of all the factors concerned that progress can be made. The 27 communications in this report include papers on selection and breeding, fertilizer and mulching experiments, deficiencies of minor elements, soil chemistry, cacao biochemistry, virus and fungus diseases and insect pests; progress is steady but much remains to be done. The new research scheme was hampered at first by shortage of staff, but latterly this difficulty has been overcome and better continuity will now be possible.

The standard of printing and production of the report is unusually high, and the 14 coloured plates showing mineral-deficiency symptoms in cacao leaves are worthy of particular congratulation.

D.W.D.

THE DEEP-LITTER SYSTEM

By M. H. French and H. P. Ledger, Joint Animal Industry Division of E.A.A.F.R.O. and E.A.V.R.O.

(*Received for publication on 3rd March*, 1954)

Some form of intensive management is necessary if maximum results are to be obtained from commercial egg-producing units, because intensification makes it easier both to maintain suitable conditions for the birds and to reduce labour hours by the full exploitation of labour-saving equipment. Admittedly, extensive range systems are a useful means of distributing manure and probably permit the maintenance of a more healthy flock, but they are more exposed to thieves and vermin and are relatively more costly in the time required for egg collection, feeding and supervision. In all systems of poultry management, personal supervision is essential, and this is more easily achieved under intensive conditions. Even when the size of the unit does not justify the employment of a trained supervisor, it is better to keep lots of 50 to 500 birds on an intensive system and to design the lay-out so that future expansion can be undertaken easily.

There are three main intensive systems, namely, battery units, poultry houses or yards, and the deep-litter (or more correctly the "built-up" litter) system. This article deals with the latter in general terms because of its topical interest, and also reports the results of a comparative experiment dealing with its effects on egg-production.

In the older systems, the floors of yards and houses were thinly covered with litter which soon became overcharged with droppings and very wet. This gave rise to the unpleasant task of cleaning out the litter at frequent intervals. During the last war, labour shortages became so acute that it became necessary to reduce the frequency of cleaning poultry houses and so the deep-litter system came into vogue and has since been enthusiastically adopted by farmers in many countries. Under this system, birds are confined in a covered pen or building on a thick layer of litter which is built up as required but removed only at longish intervals (usually annually).

Deep-litter was used originally to dilute droppings and to absorb moisture, but it is now realized that it also promotes a microbial population which breaks down both the droppings and the litter into a humus-like material, possessed of an even higher moisture-absorbing capacity. The success of the system has caused the pendulum of popular opinion to swing too far and for the method to be regarded as a panacea for many forms of poultry mismanagement. It is usually forgotten that this system requires just as much supervision, and probably more care in feeding, than any other system. Before changing to the deep-litter method, farmers should realize that its major advantage lies in its lessening of the labour of cleaning out the houses. In addition, its compactness promotes higher efficiency in management and feeding, so that one man can look after a larger number of birds. When the units are properly constructed, they also reduce the losses of birds and eggs by vermin and thieves and offer full scope for labour-saving devices and equipment.

The well managed deep-litter system is as efficient as a well organized battery unit but requires less capital. It is more economical of space, which is important in high rental areas, and is superior where the objective is to have the absolute maximum of birds attended by one man. There is, however, insufficient evidence to state categorically which is the best or the more economical system of intensive poultry management. So much depends on locality, the farm conditions, the labour position, etc., and the choice must be made in the light of all relevant factors and not simply because a neighbour or friend has found it the most suitable in his particular circumstances. The deep-litter system will never permit indifferently managed, low-producing birds to become economic propositions and there still remains the need, as in all other systems of intensive management, of removing all poor layers from the flock. Further, there can be little advantage in using the deep-litter system to save labour if there is no alternative use to which the saved labour can be put. Deep-litter probably requires the highest management skill of any system of poultry management. Numbers must be adjusted, neither too many nor too few, so that the labour can attend to the birds adequately. The litter must be checked to see that it is in a suitably absorptive state and the birds must be observed daily. This daily examination cannot be stressed too frequently, particularly from the disease control angle where birds in large units are in close

and constant contact. The health and general appearance of the birds must be watched meticulously so that sickness or disease can be diagnosed early. It is sometimes claimed that because of the intense micro-organic activity in the litter, the deep-litter system promotes a very sanitary and healthy environment for the birds. Farmers must not be lulled by such statements into a state of false security because it has not yet been proved that the conditions of the deep-litter system are always unfavourable to the existence of disease organisms. In fact, heavy parasitic populations, such as coccidia, can occur under certain conditions.

Deep-litter units should be designed to provide the birds with dry conditions and shelter from wind. A roofed, wire enclosure is insufficient. The roof must be rain-proof and nothing is more depressing than a pen of birds, on sodden deep-litter, exposed to a biting wind and driving rain. The windward end must be closed to protect both birds and litter. The enclosure must be sited to trap as much as possible of the morning and evening sun but to provide shade during the heat of the day. It is not easy to trap sunlight if the units have steeply-sloping thatched roofs and it will then be worth while considering the construction of an enclosed sun-parlour to which the birds can have access on fine days. The unit must be located so that it can be reached quickly and easily, where there is plenty of water and where natural drainage will prevent the flooding of litter by rainwater. Everything in fact must be done to meet the convenience of the management and labour whilst providing the dry conditions which have such a beneficial effect on the health, comfort and productivity of the birds.

In the early days of the system each country tended to use the kind of litter to which it was most accustomed and, whereas wood shavings were largely used in the United States of America, straws were more common in the United Kingdom. The evidence now suggests that equal parts of wood shavings and chopped straw make the best litter. Wood shavings and unchaffed straw, either alone or together, make good litter in the early stages but may later cake on the surface and deteriorate in friability if they become wet or overcharged with droppings. Straw is best chopped into short (1½ in.) lengths although good results have been reported when using long straw that has been crushed. The use of fine sand under the litter is sometimes recommended and it is often suggested that hydrated lime or oyster-shell grit should be incorporated. No special advantages appear to be derived from such additions under proper management, where the litter is kept dry, but there is a risk of the litter becoming dusty and irritating to the birds.

Birds on the deep-litter system should be provided with an average of 4 sq. ft. floor space (3½ sq. ft. in large units and 4½ sq. ft. in small flocks). In order to make the maximum use of the floor space and to prevent "dead-spots" in the litter, all perches, nest-boxes, feeding and drinking utensils are raised some 20 inches above the level of the litter. To save costs, the day-time feeding perches are often made to serve as roosting perches at night. When night-roosting perches are fitted, it is possible to arrange a collecting pit underneath so that manure unmixed with litter can be obtained for fertilizer purposes. The height of pen doors and roof should be such that the attendant can enter and work in an upright position and the units should be designed for not more than 500 birds each. The number of birds which can be handled by each attendant will vary considerably in East Africa but, in a 47-hour week in temperate areas, one man can look after 2,000–3,000 birds whilst, in the United States of America, it is claimed that 5,000 birds can be organized to form a man-unit. It is, however, generally recognized that the better the houses the better are the results and the efficiency of the management, and that over-crowding is probably the most common fault encountered.

Since the system has become popular, it has been found that the microbial decomposition of the litter is accompanied by the production of members of the Vitamin B complex. Whilst these additional supplies of vitamins, particularly B_{12}, can be of value to the birds and can enhance the hatchability of their eggs, their value has been somewhat over-stressed. There has, unfortunately, arisen the erroneous impression that birds can correct, from the litter, other and more varied nutritional deficiencies. With this, as with all other systems of intensive management, it is essential that the feed should be adequate in quantity and quality. When this is so, the advantages to be secured from additional B vitamin supplies are considerably reduced. The usual method of feeding is to scatter the equivalent of 2–2½ oz. per bird of mixed grains on the litter daily and to let the birds scratch for it. At the same time a dry mash, containing mineral, protein and vitamin supplements, should be available in

troughs so that the birds can make up their nutrient requirements. Green foods and additional lime or oyster-shell grit must always be provided, whilst an occasional sprinkling of the litter with a little coarse sand will allow the birds to secure sufficient grit for the proper maceration of their food.

When starting the deep-litter system, from 4–8 in. of fresh litter are scattered on the floor and it is probably an advantage, a few days before the birds are introduced and particularly on concrete or wooden floors, to mix with the litter a small quantity of horse manure to supply desirable micro-organisms. Cow manure can also be used but is likely to be a less concentrated supply of desirable bacteria. On earthen floors, the need for seeding the litter with bacteria is not so necessary. The birds turn the litter and mix it thoroughly but, as they may dig pits or pile it in heaps, it is desirable to rake over the litter when necessary. When the litter becomes overloaded with droppings and in the wet season, it is necessary to build it up with fresh litter and a depth of 12 in. is commonly reached. At the first sign of caking on the surface or of dampness, the litter should be forked over and, if necessary, more litter added. The view has been expressed that infestation with lice and fleas is less likely locally when cedar shavings are used instead of shavings from soft, non-aromatic woods. This point was subjected to a four-months' test at Muguga recently but the trial broke down because neither pen was troubled by the parasites.

Complete break-down of wood shavings is usually not obtained and this causes worry on how to use the litter. If a completely broken-down fertilizer is required it is better to use chopped straw alone and, if necessary, clean out more frequently. Such completely decomposed litter can be used directly as a fertilizer whilst litter containing woody shavings would probably be better used as a mulch, leaving the soluble plant nutrients to be washed into the soil by rain. The dropping-pits under the perches allow a highly concentrated manure to be collected and used for fertilizing purposes.

In view of the increasing use and misuse of the deep-litter system in East Africa, a study has been made of the relative egg-productions under the deep-litter system and when comparable birds were ranged in grass-covered wire-enclosed pens, with or without deep-litter in the houses. For this study, a group of pullets was divided at random into three equal-sized lots approximately one month before they were expected to commence laying. One group was placed in deep-litter houses, the second group on grass runs with deep-litter houses and the third group on grass runs with bare-floored houses. This procedure was adopted with three breeds, the Cambar, the Legbar and the Welsummer in order to reduce the possibility of the results being conditioned by the use of a breed particularly well adapted to one or other systems of management. In all cases the birds had been reared similarly, on identical rations, at first in neighbouring brooders and subsequently in adjacent houses with bare floors. All had been allowed to run out on grass and all were given one month to settle to the experimental conditions before the experiment began. Each pen was trap-nested and individual egg-records were kept. Each pen received the same food mixture, the grain portion being scattered on the deep-litter where this was present or on the bare floor in those houses which contained no litter. The food mixture was made up as follows:—

Dry Mash

	lb.
Maize Meal	44
Pollards	30
Lucerne Meal	10
Meat Meal	10
Cotton-seed Cake	10
Salt	1
Lime	3
Bonemeal	2
Dried Yeast	2

Grain Mixture

Oats, Millet, Barley — equal parts

These mixtures were fed at equal rates to each pen and the daily consumption increased from a total of 4¼ oz. to 4½ oz. per bird. Lime and water were always available in troughs in each pen so that the birds could help themselves. Green grass was hung in the deep-litter pen daily during the growing season whilst, in dry weather, kale was hung in all pens. The birds were placed under the experimental conditions on 1st November, 1952, and egg-production was recorded for the period 1st December, 1952, to 30th November, 1953. As all birds did not start laying at the same time and because one Legbar was accidentally killed during the experiment, neither of which

factors can be attributed to the systems of management, the figures in Table I for the average intensity of laying were obtained by multiplying the total monthly yield from each pen by the number of days in the month and dividing the product by the total number of days on which laying was possible. When the pullets were starting to lay, the number of days before the first egg was subtracted from the number of days in the month to yield the number of days on which laying was possible.

The figures in Table I show the intensity of laying as the average number of eggs laid by each bird in the respective pens during each month of the trial. These figures have been used to give the three-breed totals in Table II for each system of management and the three-system totals for each breed. By the three factor method of analysis, the following breakdown of the total variance into its component parts was obtained:—

ANALYSIS OF VARIANCE

	Degrees of Freedom	Sums of Squares	Mean Squares	Variance Ratio
Systems (S)	2	38·50	19·25	6·8†
Breed (B) ..	2	199·51	99·75	35·4‡
Months (M)	11	326·32	29·66	10·5‡
B × S ..	4	39·14	9·78	3·4*
M × S ..	22	58·73	2·67	0·9
M × B ..	22	132·13	6·01	2·1*
Residual ..	44	123·84	2·81	
Total ..	107	918·17		

*Significant at 5% level.
†Significant at 1% level.
‡Significant at 0·1% level.

The conclusions to be drawn from this analysis and from Tables I and II are:—

(1) The Cambars used in this experiment were very significantly (0.1 per cent level) better layers than either the Legbars or the Welsummers but there was no difference between the outputs from the two latter breeds.

(2) Whilst there was no difference in egg production between birds on the deep litter system and those in grass runs with deep-litter houses, the egg yield from birds in grass runs and bare-floored houses was significantly (1 per cent level) higher than from the other two systems.

(3) There were highly significant differences between monthly egg yields. The March and April productions were very significantly (0.1 per cent level) higher than the outputs during any other months. The yields in August, September and October were, at the 1 per cent level, below those of the preceding three months, whilst the November output was significantly (1 per cent level) below that of any other month.

(4) Whilst the Welsummer egg yield did not vary between treatments, both the Cambar and Legbar breeds gave higher yields (at the 5 per cent level) when no deep-litter was used than when it was present.

(5) Cambars out-yielded (at the 5 per cent level) both other breeds during January, February, March and June, significantly exceeded the Legbars in April and August and the Welsummers in July, whilst in August, Welsummer yields exceeded those of the Legbars. There were no differences between the breed egg yields during the other months.

(6) There was no significant difference between the monthly yields from the different systems except in December, when the birds on grass runs without any deep-litter exceeded those in similar runs with deep-litter in the house, and in November, when they gave higher yields than birds on either of the other two systems.

The practical implications of this experiment are that, whilst the deep-litter system has a number of advantages, it cannot be relied upon to encourage higher egg yields and, with some breeds and in some years, may result in fewer eggs. Breeds vary in their response to deep-litter systems; in this trial Welsummers laid just as well under deep-litter management as on grass runs but the Cambars and Legbars did less well on deep-litter. These results were obtained during a particularly dry year and, although no significant differences were found between treatments for the rainy and the dry months, a different result might be obtained in a wet year. It is also uncertain to what extent these results are repeatable in different environments because the highly significant variations in egg yields for different months could not apparently be related to any of the climatic factors recorded on the adjacent meteorological station.

TABLE I.—AVERAGE RATE OF EGG PRODUCTION

		Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Yearly Total
Deep-Litter ..	Cambar ..	14·29	18·32	16·69	20·10	17·80	16·20	15·70	13·30	11·20	9·00	10·20	8·30	171·10
	Legbar ..	12·86	10·23	9·10	13·39	12·54	12·43	10·89	13·42	6·79	9·99	8·99	8·01	128·64
	Welsummer	8·73	10·60	11·82	16·58	15·24	11·90	9·00	10·57	11·75	11·07	12·59	9·84	139·69
Grass-run and Deep-Litter House	Cambar ..	9·51	15·41	15·79	20·40	15·10	14·20	14·90	12·90	11·60	11·70	13·67	9·90	165·08
	Legbar ..	11·38	8·68	9·66	12·49	13·17	14·01	11·01	11·50	9·49	10·41	9·83	8·49	130·12
	Welsummer	9·64	11·35	12·10	15·00	15·81	11·84	13·92	13·33	13·67	11·82	8·00	7·68	144·16
Grass-run and Bare-floored House ..	Cambar ..	16·00	15·00	12·90	19·40	18·20	13·50	18·90	17·10	15·10	12·00	15·00	14·50	187·60
	Legbar ..	12·43	11·00	12·26	16·18	16·08	12·99	14·10	16·27	9·55	12·45	14·72	12·18	160·21
	Welsummer	12·55	10·54	8·90	13·17	14·67	13·92	8·75	10·10	12·15	13·08	10·26	9·09	137·18
Monthly Total ..	All Breeds	107·39	111·13	109·22	146·71	138·61	120·99	117·17	118·49	101·30	101·52	103·26	87·99	1,363·78

TABLE II.—EGG YIELDS FROM THE THREE MANAGEMENT SYSTEMS AND THE THREE BREEDS

(*a*) EGG OUTPUTS ACCORDING TO SYSTEMS OF MANAGEMENT

	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Yearly Total
Deep-litter	35·88	39·15	37·61	50·07	45·58	40·53	35·59	37·29	29·74	30·06	31·78	26·15	439·43
Grass-run and Deep-litter House	30·53	35·44	37·55	47·89	44·08	40·05	39·83	37·73	34·76	33·93	31·50	26·07	439·36
Grass-run and bare-floored House	40·98	36·54	34·06	48·75	48·95	40·41	41·75	43·47	36·80	37·53	39·98	35·77	484·99
TOTAL ..	107·39	111·13	109·22	146·71	138·61	120·99	117·17	118·49	101·30	101·52	103·26	87·99	1,363·78

(*b*) EGG OUTPUTS ACCORDING TO BREED

	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Yearly Total
Cambar	39·80	48·73	45·38	59·90	51·10	43·90	49·50	43·30	37·90	32·70	38·87	32·70	523·78
Legbar	36·67	29·91	31·02	42·06	41·79	39·43	36·00	41·19	25·83	32·85	33·54	28·68	418·97
Welsummer	30·92	32·49	32·82	44·75	45·72	37·66	31·67	34·00	37·57	35·97	30·85	26·61	421·03
TOTAL ..	107·39	111·13	109·22	146·71	138·61	120·99	117·17	118·49	101·30	101·52	103·26	87·99	1,363·78

OBSERVATIONS ON THE SORGHUM SHOOT FLY

By Gordon Swaine and Catherine A. Wyatt, Department of Agriculture, Tanganyika

(*Received for publication on 23rd March, 1954*)

Whilst not being of such general importance as the Lepidopterous stem borers, *Busseola fusca* and *Proceras argyrolepida*, the shoot fly *Atherigona indica* Mall., can be a troublesome pest, particularly in sorghums which have been planted late or out of the normal season. The insect is widely distributed throughout Tanganyika but appears to cause most damage in the drier areas of the Territory. An opportunity to study the pest arose recently at Morogoro farm on short-term sorghums being grown towards the end of the dry season under irrigation. A first planting, made on 3rd October, 1953, was already 22 days old when encountered by the writers but facilities for further plantings to study the early phases of *Atherigona* attack were made available by the Agricultural Officer in charge.

Biology

The eggs are white in colour, about 0.8 mm. in length and 0.2 mm. wide, finely sculptured on the outside and possess a raised, flattened keel running along the mid-length. They are laid singly, usually at night, on the underside of the leaf, the long axis being parallel with the veins. Usually only one or two eggs are laid at a time on each leaf; the maximum number found in these observations was six.

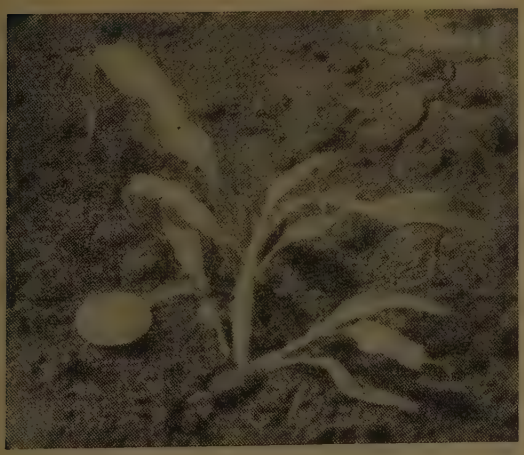

Plate I—Young sorghum plant attacked by Atherigona reacting by production of side tillers. (East African shilling adjacent.)

The eggs hatch at night, two days after being laid, the first stage larva passing down between the outer leaves and the inner tightly furled leaves of the young plant and eventually boring horizontally through these to the young growing tissues. Continued feeding on these results in the rotting of the heart and the drying and yellowing of the central furled leaves. The young plant reacts to the attack of *Atherigona* by the production of side tillers (Plate I). These in their turn may be successively attacked by newly emerged larvæ and the production of a main leader shoot may be prevented. In a severe attack the general growth of a planting becomes very irregular with plants either not heading or heading at different times.

Moults take place in the rotting heart, three larval stages being produced. Pupation occurs either in the soil or in the basal parts of the stem. Life history studies were made on the plants taken from the field when bearing fresh eggs and planted into bamboo pots in an insectary. The plants were examined at intervals to determine the length of the three larval stages. Details of the life cycle obtained in this way are given in Table I.

Table I—Life Cycle of Atherigona Indica

(*Average temperature 81° Fahr.*)

Stage	*Average length in days*	*No. of observations*
Egg	2	21
Larva I	2	1
Larva II	3	3
Larva III	3	4
Pupa	6.8	5
Total	16.8	

Field Infestation

Observations on the progress of infestation in the field were made on the short-term sorghum variety TADA. This was planted on the 3rd November, 1953, in 30 plots (144 plant hills to the plot) to allow of later replicated insecticide treatments. The plants were thinned to two per hill during the first week after germination and five such hills in each plot were then picked at random and marked for counts on egg laying.

Egg laying began 7–8 days after germination when the plants were about 2 in. high and continued up to the time the plants began to head. Counts of unhatched eggs were made every second day, counted eggs being removed so as to prevent possible error in the subsequent observation. The results are given graphically in Fig. I. Counts were discontinued after the 48th day owing to the large and increasing leaf area which had to be inspected. From the form of the curves it would appear that the second and partial third generations recorded were due to the build-up from the first invasion rather than to continued ingress of egg-laying females from outside the plots. The number of days (16) between the two peaks in Fig. I, indicating the time occupied by one generation in the field, agrees very closely with the figure of 17 days obtained from laboratory breeding.

CONTROL

Van Der Laan (1) working on a related species, *Atherigona exigua* Stein, which attacks seedlings and young plants of dryland rice in Java, came to the conclusion that seven or more insecticide treatments were necessary within the first 10–12 days after germination in order to effect a control. From the form of the egg-laying curves (Fig. I) it would appear that *Atherigona* in Tanganyika could be controlled by the suppression of the first invading generation with insecticide applications from about the 9th to the 30th day after germination. However, there is the possibility that additional control for the Lepidopterous stem borers, *Proceras argyrolepida* and *Busseola fusca* would also be required; in one experiment at Morogoro. *Proceras* was in fact more troublesome than *Atherigona*. From observations made in Eastern and Western Provinces it is known that *Proceras* and *Busseola* are not attracted to lay eggs on sorghum until it is about 2–3 weeks old and the first stage larvæ do not emerge until five or 9 days later respectively. By this time *Atherigona* has almost managed to complete its first generation. If control of *Atherigona* on the lines of those worked out in Java were adopted, the additional control of the later emerging *Lepidopterous* borers would make complete protection uneconomic. In experiments at Morogoro a compromise schedule of insecticide treatments at weekly intervals was adopted as below:—

Experiment I.—This was carried out on plantings of the two short-term sorghum varieties, Early Shallu and TADA, which were 22 days old when first encountered by the authors. Five weekly dustings were made with 2.5 per cent D.D.T. plus 5 per cent Toxaphene in diatomite at the rate of 10 oz. per 1,000 plants. The infestation was a mixed one of *Atherigona* and *Proceras*, the former well in evidence when dusting began. One-half of each plot was dusted, the remaining half being left as control. Counts of headed plants made sixty and seventy-five days after planting are given in Table II.

TABLE II—SHORT-TERM SORGHUMS DUSTED FIVE TIMES WITH 2.5 PER CENT D.D.T. PLUS 5 PER CENT TOXAPHENE

Number of Headed Plants

Days after planting	*Variety Early Shallu*		*Variety TADA*	
	Control	*Treated*	*Control*	*Treated*
60	415	1,468	Not ready	
75	Not ready		385	1,079

Yield figures, only available for variety TADA, showed no significant differences, which may be explained by the recovery of the control plots due to light regular rains in January having an adverse effect on *Atherigona*. It was noted from detailed egg counts on marked plants that night rain in particular depresses the number of eggs laid.

Experiment 2.—Five weekly dustings were made with 2.5 per cent D.D.T. alone and in combination with BHC, Toxaphene and Aldrin (all in diatomite) on the short-term sorghum TADA, beginning nine days after germination. All dustings were at the same rate, 10 oz. per 1,000 plants and six applications of each treatment were made. Comparisons of the number of eggs laid on five randomly selected plant hills (two plants per hill) in each of the thirty plots indicated that adult insects were not repelled by the treatments. There was a difference in the numbers of damaged hills as indicated in Table III but no real differences in final yield figures. It is probable that the incidence of *Atherigona* was not really high enough in this experiment to have any real effect on yield.

Some falling off in numbers occurs towards the end of the records, due to the fact that withered hearts are readily blown away by wind and the former damage thereby overlooked when counts are made.

TABLE III—SORGHUM DEAD HEARTS CAUSED BY ATHERIGONA INDICA MALL. (SORGHUM VARIETY, TADA)

Number of damaged plant hills

Days after germination	*2.5% D.D.T. plus 1.5% gamma BHC in diatomite*	*2.5% D.D.T. plus 5% Toxaphene in diatomite*	*2.5% D.D.T. plus 2.5% Aldrin in diatomite*	*2.5% D.D.T. in diatomite*	*Control*
19	24	42	26	79	51
21	29	66	27	122	117
26	39	88	73	106	182
28	79	152	112	195	275
33	151	197	160	298	274
35	131	191	163	359	396
40	155	170	196	340	469
42	125	170	275	336	409

Total plant hills per treatment=864.

DISCUSSION

Despite the brief duration of the egg stage of *Atherigona* and the shortness of the life cycle allowing of more than one generation during the growing susceptible period of the plant the indications are that sufficient control can be obtained by weekly applications of insecticide. Large differences in the numbers of headed plants were obtained between treated and untreated plots in one experiment where the first dusting was not made until 22 days after planting, although more prompt measures would seem desirable to allow of the early establishment of a leader shoot. Ideally, insecticide control should begin seven or eight days after germination when egg-laying by *Atherigona* begins. From counts of the numbers of damaged hills the best insecticide tested for the control of *Atherigona* was the one containing benzene hexachloride. D.D.T. by itself gave results little different from the control. The mixture containing BHC caused delayed scorching of the young plants, which appeared as withered and drying leaf tips as the plants became older. No ultimate adverse effect could be detected but it is obvious that some care in the application of BHC. to young sorghum plants is required.

In this Territory, where there is a possibility of a later attack of Lepidopterous borers, it would seem that any control measures against *Atherigona* should also be designed to control these additional pests. It is for this reason that D.D.T., which is known to have good killing properties against moth larvæ and which is used extensively against *Busseola* in South Africa, was used in combination with the other insecticides, BHC, Toxaphene and Aldrin, and that a weekly schedule of dustings to cover the immigration period of moth borer was adopted.

SUMMARY

1. An account is given of the biology of the sorghum shoot fly—*Atherigona indica* Mall.

2. Egg counts in the field indicated that *Atherigona* attack begins 7–8 days after germination and that second and succeeding generations owed their origin more to the egg-laying of the first invading generation rather than to continue ingress of egg-laying females from outside the plot.

3. Control measures are discussed and evidence put forward that a sufficient control of *Atherigona* can be obtained by a schedule of weekly applications of insecticide. Ideally these should begin 7–8 days after germination to allow of the early establishment of a leader shoot. In experiments five weekly applications of insecticide were made to cover the immigration period of both *Atherigona* and Lepidopterous borer.

4. Of the insecticides tested a dust containing 2.5 per cent D.D.T. plus 1.5 per cent gamma BHC. in diatomite at the rate of 10 oz. per 1,000 plants held most promise.

REFERENCE

[1] Van Der Laan, P. A. (1951).—Life history and control of the Rice Seedling Fly—*Contr. gen. agric. Res. Sta. Bogor.* 118. Summary. *Rev. Appl. Ent. Ser.* A (1953) 41, 59.

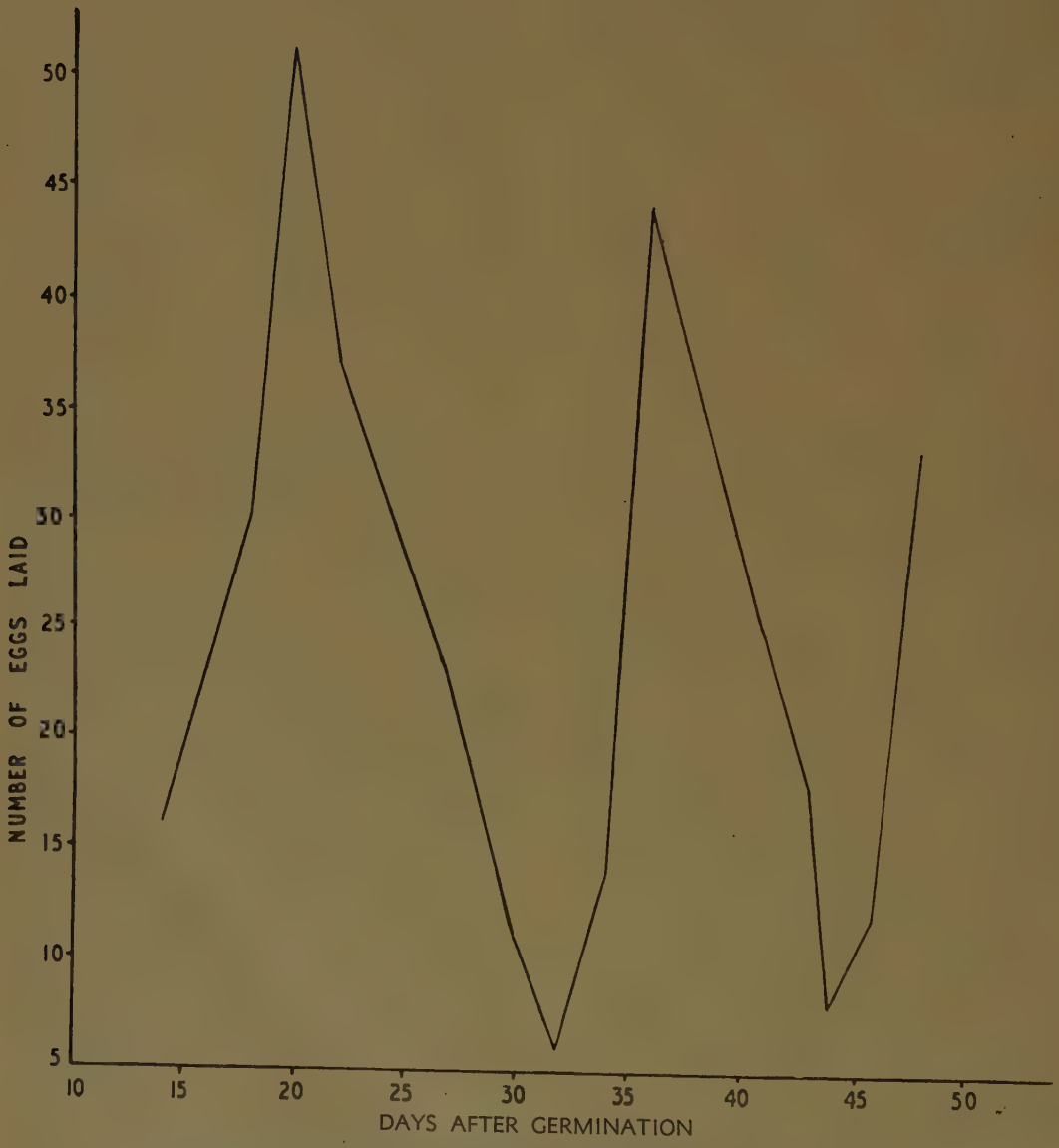

Fig. I—Number of eggs laid by Atherigona on short-term sorghum variety TADA. (300 plants per sample.)

TREE-PLANTING IN TANGANYIKA

IV—Species for Coastal Areas

By M. S. Parry, Forest Department, Tanganyika

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Previous articles have dealt with methods of planting, and with species commonly planted in the Highlands and in dry areas. This, the final article, describes the commoner species suited mainly to lowland and coastal districts. Most of the species previously mentioned as suitable for dry areas will grow equally well or better at the coast. Species such as Flamboyant and the Mango for example are a familiar sight in coastal townships while *Afzelia* and Mninga occur in the lowland forests as well as in the drier up-country districts. Fuel plantations of *Cassia siamea* are as common on the coast as anywhere.

Acacia auriculiformis

A "wattle"-like species which has not yet been planted in Tanganyika but which will probably be used a great deal in future, in view of the success of recent plantations in Zanzibar. It is fast-growing and does remarkably well on the poorer coastal sands, forming a dense canopy and suppressing grass quickly, where *Cassia* would remain stunted. The best Zanzibar plantations have reached about 35 ft. in six years.

The form is poor but the poles could be used for native buildings. The heartwood is fairly hard and it is expected to make good fuel or charcoal. Its main value will be for planting as fuel on poor sites. On the better sites it would be outclassed by *Eucalyptus,* as it is unlikely to reach a height much greater than 50 ft. It can be regenerated from coppice. Seed is not easy to obtain at present, the only local source being Zanzibar.

Adenanthera pavonina (Bead Tree)

A light foliaged ornamental tree commonly planted in townships and gardens of the coastal belt. It is not particularly ornamental, the main interest being the curious bright red seeds which are produced in curly pods in great numbers. There are 1,600 seeds to a pound. The wood is hard and red, used for building and cabinet work in Asia.

Bombax rhodognaphalon (Wild Kapok)

An indigenous tree related to the true Kapok, occurring in moist thickets of the coastal belt. It is a large tree with clean, straight, smooth and rather greenish bole. The timber is light and brown, resembling a soft mahogany. It is not durable but is easily worked and strong for its weight. It is very suitable for roof construction, good quality wooden cases, etc. The fruit resembles Kapok, except that the floss is reddish brown and of no commercial value.

This species has not been raised in plantations, but a few limited trials at Morogoro and E. Uluguru suggest that it is easy to raise from seed and grows fairly quickly. Its clean form would make it suitable for growing as a timber species at a wide espacement, and it could be recommended for good soils in moist foothill areas.

Cassia fistula (Indian Laburnum)

A small ornamental tree which produces masses of beautiful yellow pendulous flowers. It deserves to be more widely planted in gardens in the lowland towns of Tanganyika as it is not particularly common at present. The bark is astringent and used in India for tanning and native medicines.

Cassia nodosa (Pink Cassia)

A very beautiful ornamental tree, with a spreading habit, and trailing branches, which produces masses of pink flowers for a few weeks in November–December. Seed weighs 1,600 to the pound and is easily obtained, but germinates with difficulty. It requires boiling for a few minutes and subsequent soaking to remove the mucilaginous coating. Can be planted by means of stumps or potted transplants. In Morogoro on deep soil or near a garden furrow it grows rapidly reaching 10–15 ft. in three or four years, and flowering after three years.

Casuarina equisetifolia (Beefwood)

A tall graceful tree, with fine green branchlets bearing reduced scale-like leaves. It is a conspicuous ornamental tree on the sandy soils of coastal townships where it has been planted since pre-German times. It also grows fairly

well on light soils in up-country Stations with a rainfall of 30–40 in. The timber is tough and is useful mainly for large-sized poles, e.g. dhow masts. The tree does not coppice very vigorously but would be useful as a pole or fuel species on the impoverished coastal sands. It grows very rapidly (4–8 ft. per annum) and in fact will keep pace with *Eucalyptus*.

Seed is produced in great quantity several times a year and is very small (about 100,000–300,000 per lb.). It germinates well and the seedlings grow very rapidly, needing only 3–4 months in the nursery. Planting can be done in a normal year with bare-rooted plants, but for regular planting boxes or pots should be used. This species forms mycorrhizae and it is often recommended that transplant beds should contain soil from beneath old trees, but this is not usually necessary. On poor soils the trees may check and turn yellow in the first year but they soon recover.

Cedrela odorata and spp. (South American or "Cigar-box Cedars")

There are several species of *Cedrela* and the related genus *Toona* all known as "Cigar-box Cedars". The species most suited to coastal conditions is the one growing well in avenues at Morogoro, believed to be *C. odorata*. This tree has a handsome foliage, and is usually straight growing. It is suited mainly to deep soils in moist, coastal or foothill regions, with a rainfall 35 in. or more below 3,000 ft., but it is surprisingly drought-resistant, and is even managing to grow in such unlikely places as Itigi and Sukumaland. It will not grow well above 4,500 ft.

The timber is light, brown, fragrant, easily worked, and durable, in fact very useful for a variety of purposes. All the *Cedrelas* give the so-called "cedar-wood" used in Central America for cigar boxes.

The tree is often planted in townships, but this species can hardly be recommended as an ornamental owing to its habit of producing a disgusting odour, somewhat reminiscent of garlic or burning rubber, during the flowering season.

The seed is very light, and winged, averaging about 100,000 to a pound. It is easily obtainable and germinates readily. The tree is easy to plant from pots or boxes, needing about 5–6 months in the nursery. It can also be planted as stumps obtained from 8–12 months old transplants.

In the E. Usambara foothills (70 in. rainfall at 1,300 ft.) *C. odorata* plantations have reached 100 ft. in 40 years. The diameters are small owing to neglect of thinnings but marginal trees are about 18 in. diameter. In these ideal situations high yields of useful timber could be expected, probably about 6,000 cu. ft. per acre in 35 years.

There are also plantations of *C. mexicana* and *Toona ciliata* (=*Cedrela toona*) in the same locality. The former has grown well but is now becoming diseased and stag-headed. The latter is mostly diseased and badly shaped.

Ceiba pentandra (Kapok).

A well-known tree widely established in commercial plantations of the coastal belt but also extending up-country as an ornamental tree in townships. The form is erect, with a stout bole often bearing raised bosses, and horizontally whorled branches.

The timber is soft and useless except for light box-shooks, but the seeds are embedded in the white cottony kapok which is a valuable commercial product. A good 15-year old tree is said to yield from 600–900 pods or 6–9 lb. of clean kapok in a year, but the yield varies considerably.

The seeds average about 5,000 to a pound and germinate easily. The tree can also be raised from cuttings or stakes. It grows rapidly in favourable situations.

Although often planted in townships Kapok cannot be recommended as an ornamental, as it is leafless for a long period, and makes a great mess when fruiting heavily.

Chlorophora excelsa (Mvule)

The best-known and most valuable indigenous timber species, occurring as scattered trees in moist lowland secondary forest and in cultivated land on the eastern foothills of mountains, also around Lake Victoria, Lake Nyasa and in coastal thicket and cultivation. When young, it averages 3–4 ft. height growth per annum, and appears to attain timber dimensions in about 60 years.

Seed averages about 200,000 to a pound and is easily extracted by squeezing the mulberry-like fruit under water. If dried it can be stored for some time but there is appreciable loss of viability after 12 months. The tree is dioecious, i.e. male and female flowers are born on different trees, and fruits can be collected under female trees about January. Seed germinates very easily when fresh.

Planting can be done by means of stumps obtained from two-year-old transplants, but unfortunately the plant when young is very subject to browsing damage, and also to infestation by a leaf gall insect (*Phylolyma lata*) which causes the young saplings to check badly and develop a branchy habit. In order to overcome the browsing problem Mvule is often planted by means of very large "striplings" which are put out at a wide espacement under light canopy. The "striplings" are three-year-old transplants 6–8 ft. high. On planting out, the main roots are pruned off, and most of the leaves removed. Striplings are rather expensive to raise and handle, but the wide espacement (about 30 ft. by 30 ft.) enables a large area to be covered with a small number of plants. The incidence of gall can be reduced by planting it in mixtures with other species, such as *Khaya*.

The lateral roots of mature Mvule trees run very close to the surface, for great distances (up to about 100 yards). When exposed and damaged the roots send up vigorous sucker shoots. It is probable that the prevalence of Mvule in cultivated land is due largely to the stimulation of root suckers. Mvule coppices readily, but coppice shoots from very big stumps are liable to die back or get blown over after a few years. On account of gall infestation Mvule is not suitable for planting in close espacement as a pole crop.

Eucalyptus spp.

There are many species of Eucalyptus which are suitable for planting in moist localities in lowland areas. The main drawback of these species is their susceptibility to termite damage. (*See* note under species for Mountain Areas.) Where termites are not a serious danger, *Eucalyptus* species can be relied upon to grow rapidly and produce good fuel or straight poles. Of the species usually recommended the following may be mentioned:—

E. citriodora.—(*See* Part II dealing with Mountain areas.)

E. robusta.—A species capable of reaching large dimensions but requires plenty of subsoil moisture. It is fairly resistant to waterlogging but will not survive on land which remains swampy for weeks at a time. Rather slow growing for a Eucalypt.

E. resinifera.—A fairly drought resistant species which has grown fairly well on coastal sands. It is not suitable for swampy soil.

E. camaldulensis (=*E. rostrata*) (Red Gum).—Has not been planted on any scale in Tanganyika but is reputed to be not only very drought resistant, but also exceptionally able to withstand waterlogging. It should be very suitable for planting on land liable to temporary inundation, and in conjunction with a drainage scheme may be recommended for planting as a means of assisting in the control of mosquitoes. It grows rapidly, especially on land with plenty of subsoil moisture, but has a rather poor form. Suitable mainly for fuel, or rough poles, but the timber is also used in South Africa for rough work. A variety of this species or a closely related species is growing well in Zanzibar and is of good form.

E. saligna.—A useful species, for fuel, poles and rough timber, fast growing, and of good form. It prefers plenty of subsoil moisture, but will not grow in stagnant waterlogged soil. Has been planted extensively on drained, semi-swamp land around Lake Victoria in Uganda and Bukoba, in order to provide fuel and assist in malaria control. It is showing promise on recently-cleared forest land near Dar es Salaam, even on fairly dry sites, and is expected to grow very well there in the valleys.

E. saligna poles have been found to split badly on drying but this can be alleviated by leaving the tree lying for some months after felling with the crown and branches intact.

E. tereticornis.—A species with characteristics similar to *E. camaldulensis*. It is far less able to withstand inundation, but is about equally drought resistant. It has a rather better form, yields a more useful timber, but is slightly slower growing.

Hura crepitans (Sand-box Tree)

A pleasant foliage tree with dark shining foliage and a curious explosive fruit. It is of no value for timber but makes a good shade tree for gardens. It is growing well on alluvial soil at Morogoro. There are 350 seeds to a pound.

Khaya nyasica (E.A. Mahogany)

A large and valuable timber tree. Common in riparian forests of the coastal belt. Suitable for planting along rivers or on good alluvial soils. The seed averages about 1,500 to a pound and germinates well. It is usually planted as 1-year or preferably 2-year stumps or striplings. It grows fairly fast and in Morogoro has reached 30–40 ft. in about seven years in riparian sites. If grown in plantations it is likely to suffer damage from a shoot borer.

Lagerstroemia flos-reginæ (Pride of India)

A medium-sized spreading tree with masses of very showy mauve or pink flowers. It can be raised from seed but germination is usually poor. The seeds need to be well soaked. For ornamental use it is usually raised from cuttings. This species withstands waterlogging fairly well and is often planted in swampy places. In Burma it is an important timber tree but few trees in East Africa have reached timber size. A related species *L. tomentosa*, with white flowers, is also planted for ornament.

Leucaena glauca

A small vigorous tree or shrub planted for hedges, small fuel, or anti-erosion work. It spreads vigorously by seeding and from suckers and if not controlled could easily become a nuisance in gardens or *shambas*. Its main value is in covering poor soils to stop erosion, for which it could be sown direct. There are about 10,000 seeds to a pound and they can be collected in large quantities in Morogoro and Amani where this species is something of a pest.

Millingtonia hortensis (Indian Cork Tree)

A very tall ornamental tree with an erect habit reminiscent of a Lombardy Poplar. Produces large quantities of very sweetly scented trumpet flowers. The timber is of no particular value, but the mass of upright branches would yield plenty of soft poles or stakes. Seed is very difficult to obtain, but the tree can be planted easily by means of root suckers which occur in abundance around mature trees. These sometimes prove to be a nuisance in a garden. The suckers do not transplant very easily, and it is best to line them out in a nursery for six months, and plant out large pruned transplants, or striplings, about 12–18 in. high.

Parkia javanica

A large fast-growing tree with enormous buttresses and attractive feathery foliage. A few are growing in a main street of Tanga but the great spreading roots do not make it very suitable for street planting. It would be an attractive species for parks or large gardens. The seeds are large (500 per lb.) and the pods are borne in clusters from a large pendulous knob.

Peltophorum ferrugineum

A shade or avenue tree with a dense foliage, planted along several streets in Dar es Salaam and elsewhere. The clusters of brownish-yellow flowers and russet-coloured pods are quite ornamental. Can be planted from stumps, or potted transplants. Seed is easily obtained but very difficult to germinate. There are 5,000–8,000 seeds to a pound. It is best to soak the seed for 12 hours and sow thickly. Coppices readily. Fairly fast growing, equalling *Cassia siamea* in places, and, if it were easier to plant, might be recommended as an alternative to the latter for fuel plantations near the coast, as it provides a denser ground cover.

Pongamia glabra (Indian Beech)

A dense-crowned foliage tree with attractive beech-like foliage. It is drought-resistant and deserves to be tried more as a shade tree on coral soils at the coast. There is one tree growing well in Tanga near the sea front. It seeds and regenerates prolifically. The seed is large, and could be sown direct. It occurs in single-seeded pods which weigh about 200 to the pound.

Pterocarpus indicus

A fast-growing tree which can be raised from seed or more easily by striking large cuttings which can be simply hammered in like stakes, but which should preferably be planted in prepared pits. It has a spreading habit and is of little value except for anti-erosion work and for firewood, but it can be planted easily, and it rapidly smothers grass, forming a dense thicket 10–20 ft. high in about 4 years. Although often called "Padauk" this species is not the one producing the fine timbers of that name which come from two related species.

Samanea saman (Rain Tree)

A large fast-growing, very handsome shade tree, which is growing well in Dar es Salaam, Tanga, and in gardens at Morogoro. There is also an avenue of it in Kondoa. Has a spreading habit, and tends to be short-lived. Mature trees are liable to shed large branches without warning. Seed germinates fairly easily after it has been soaked in hot water. Can be planted by means of stumps or potted transplants. The sticky pods are relished by cattle, and the tree should be a useful shade tree in pastures, particularly as it appears to have a vitalizing effect on grass growth. The flowers are pink and attractive but usually not very numerous. Seed averages 2,500 per lb.

Sapindus saponaria (Soap Berry Tree)

A medium-sized tree of no great attraction but commonly planted in avenues and gardens, as it is very hardy and survives on the poorest coastal soils. There are several avenues of it in Tanga. The seed is a hard black marble encased in a yellow gelatinous sheath which is commonly used by natives for soap. There are 350 seeds to a pound.

Syzygium cumini (Zambarau)

A handsome, dense-crowned tree with dark shining foliage, which also produces an edible plum-like fruit. It grows well on the coast and will also survive in quite dry places up-country. It is rather slow-growing, and is usually raised from seed by means of potted transplants.

Tectona grandis (Teak)

One of the world's most valuable timbers. It has not been planted on a large scale in Tanganyika but sufficient trial plots exist to indicate that it will grow well in the moister lowland areas, such as on the wetter eastern foothills of mountain areas below 3,000 ft. It will grow fairly well in drier situations (e.g. the Dar es Salaam botanic gardens and Morogoro township), but for optimum growth it needs a deep well-drained soil, with either subsoil moisture, or a rainfall in excess of 40 in. It is most easily planted by means of stumps about $\frac{1}{2}$ in. in diameter, obtained from one-year-old seedlings. The seed is contained in a hard felty fruit, and can be persuaded to germinate most easily by spreading the fruits on the surface of a seed bed, and watering copiously without shade, allowing the fruit to dry out under a hot sun between waterings. Alternatively, the fruits can be charred by covering them with a thin layer of dry grass, and allowing a light fire to run over them. The fruits average about 500 to the pound and should be spread at the rate of about 5 lb. per square yard. The seedlings should be shaded for a while when germination begins, though this is not essential. For stump-planting it is not necessary to transplant. In India, Teak is often established by direct sowing, but it has been found difficult in local trials to obtain adequate germination. Teak is very fast-growing when young, sometimes exceeding 6 ft. per annum for the first few years and is usually straight-growing. It is therefore suitable for fuel or pole plantations. It coppices vigorously when felled. For timber plantations a spacing of 10 ft. by 10 ft. is recommended, but a closer spacing may be adopted if there is a demand for thinnings. The poles are straight and strong, but, being sapwood, are not very durable. It is not possible to quote yields from local plantations, but in India (Nilambur plantations), the total yield on a rotation of 80 years is about 6,800 cu. ft./acre on the best sites.

Terminalia catappa (Indian Almond)

A familiar avenue tree in coastal townships with the branches arranged in regular whorls and large rounded leaves often with a reddish colour. The tree is attractive but rather messy for avenue planting, as it sheds its leaves frequently. The fruit is edible. It grows fairly quickly and yields a useful timber. It is normally raised from seed.

THE ESTABLISHMENT OF CHLORIS GAYANA UNDER A SORGHUM SILAGE CROP

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In grassland practice, if the widespread introduction of a new or improved husbandry method is to be successful, the change should involve the minimum of extra expenditure of time, money and effort. This is particularly true in a country like Uganda which has mainly a peasant agriculture. If it is desirable to replace natural regenerated herbage, after cropping, with a seeded ley, the change should be carried out with little more than the expenditure on the seed. This can only be accomplished by establishing the grass under the last arable crop. During 1953 at Entebbe one observation plot of *Chloris gayana* was sown under a sorghum cover crop. This paper is a record of these observations, together with a discussion of the implications when applied to agriculture in general in Uganda.

During May, 1953, beans and sorghum were sown in one paddock of five acres at the Livestock Experimental Station, Entebbe. This was the first crop after the land had been broken from an *Eragrostis mildbradii, Brachiaria decumbens* and *Cynodon dactylon* permanent pasture. In one direction of the field sorghum was sown in 20-in.-spaced drills, whilst at right angles to these, alternate 20-in.-spaced drills were sown with sorghum and beans. The total seed rate worked out at 11 lb./acre for sorghum and 20 lb./acre for beans. For observational purposes two strips, each 120 yards long and 8 yards wide, one of *Chloris gayana* and one *Melinis minutiflora,* were sown immediately after the cross-planting. The grasses were sown broadcast on 28th May, the *Chloris* at 20 lb./acre and the *Melinis* at 12 lb./acre. Between 4th and 7th August the beans and sorghum mixture was cut for silage.

The first rain after planting fell on 31st May but the total rainfall during the period of growth of the silage crop was much lower than the average. The rainfall on 31st May was 0.27 in. During June rain fell on seven days to give a total of 1.70 in., and during July rain fell on nine days to give a total of 2.29 in. for the month. These compare with average figures of 4.76 in. for June and 3.38 in. for July. From 9th July to the end of cutting on 7th August no rain fell.

The sorghum and the *Chloris* both germinated well and grew steadily from planting. When the sorghum was cut the *Chloris* was between 18–24 in. high along the whole strip, whilst the sorghum varied from 2–6 ft., according to changes in soil fertility. After harvesting the sorghum, the *Chloris* strip was seen to be almost clear of weeds. This was in marked contrast to the high weed population on the area which was not undersown. The weeds in the paddock mainly belonged to the Compositae, Labiatae and Malvaceae families and included *Bidens pilosa, Spilanthes acmilla, Aspilia latifolia, Leonotes africana* and *Sida rhombifolia.* Thus, from this observation trial it appears that not only can *Chloris gayana* be established successfully under a silage cover crop, but that the combination of sorghum and *Chloris* can compete with and suppress the seedlings of many weed species which could not be suppressed by the sorghum alone.

In contrast to the success with *Chloris,* the undersowing with *Melinis minutiflora* gave very disappointing results. When the sorghum was cut very few plants of *Melinis* were found and the whole strip was a mass of weeds. A partial explanation of this may be found in the difference between the germination potential of the seeds of the two species. Laboratory germination tests showed that the *Chloris gayana* seed had a germination value of 33 per cent whilst the *Melinis minutiflora* had, under the same test conditions, a germination value of only 5 per cent. In passing, it should be remarked that this was an exceptional sample of *Chloris gayana,* since the majority of the samples of seed of this species tested here to date have had less than 10 per cent germination. It is interesting to speculate whether the same results in the field would have been achieved if seed of a lower germination potential had been used. This, of course, emphasizes the need for seed to be sold with a guarantee of germination potential.

Discussion

The fact that *Chloris gayana* can be established successfully under a sorghum silage crop opens up new possibilities for the future

development of crop rotations. In many districts of Uganda a cereal is or could be the last crop in the rotation [4]. At present these crops are grown entirely for their grain, but as the cattle population increases in relation to the area of uncultivated land the need for supplementary feeding and for the established ley will increase.

At Kabete, in Kenya, Edwards has shown that both *Chloris gayana* and *Bothriochloa insculpta* can be successfully established from seed under a maize crop [1]. More recently, at Kitale (also in Kenya), *Melinis minutiflora* has been established under maize [2]. This practice of undersowing does not appear, however, to have been adopted in Uganda either by the Experiment Stations or by the local inhabitants. It is possible that as sorghum is grown over a wider range of conditions the practice of undersowing sorghum may be accepted in preference to the undersowing of maize. There does not appear, however, to have been any attempt to try and establish grasses under a sorghum cover crop.

For the most part, the cattle in the mixed farming area of Uganda are at present grazed outside the arable lands. The main grazing grounds are on and around the swamps and on land where the soil is too poor or too shallow to permit cultivation. The major restriction to the use of cultivated ground is the strip system. Under this system the strips of ground which are being rested are interspersed among the strips of cultivation, consequently grazing the resting strips entails either the risk of damage to crops, or the employment of large numbers of herd boys. Attempts are being made to encourage the adoption of a block system of cultivation, where all the resting land is in adjacent strips [3]. As the human population and the cattle population increase, the area of rough grazing available per cow diminishes, and therefore cultivated land will have to provide more cattle food. This can be achieved firstly by providing grazing on the resting strips and secondly by growing foods specifically for animal consumption. On the grazing strips a decision will have to be made as to whether grass should be sown or whether the area should be allowed to regenerate naturally.

Experimental evidence so far has not proved the absolute superiority of the *Chloris gayana* ley over natural regeneration. The chief advantage of a *Chloris* ley is that a quick ground cover is produced and grazing at an early date can be expected. In the second and subsequent years of rest, provided a good grass cover is established, there appears to be little difference between a sown ley and naturally regenerated grassland. Thus, the earlier the pasture is established the greater its superiority and the higher the chances of economic gain. Undersowing will probably best meet this requirement.

The growing of crops by the African farmer, especially for cattle food, is likely to be a later development in agricultural progress. At present, progressive farmers feed crop residues and, in some cases, sweet potatoes and cassava to their cattle. On the experimental stations crops of sweet potatoes are often grown for animal-feeding. The sweet potato crop, however, does not appear to be a good crop to grow in large fields. Since the tuber cannot be stored out of the ground for any length of time, the crop has to be lifted and fed as required. If only one field of sweet potatoes is grown to feed to animals as a supplement to grazing, the next crop has either to be sown in small areas as the potatoes are harvested, or sowing has to be delayed until all the crop is cleared. Neither alternative is really satisfactory when the aim is to provide the best return of food per acre. In addition, the drawback to the sweet potato crop is the inability to predict the yield within a narrow range before the crop is harvested. This makes the rationing of food to livestock a gamble rather than a certainty. As an alternative to sweet potatoes a green crop for silage could be grown.

A variety of crops can be grown for silage. The object in this production of supplementary feeding should be to grow as large crops as possible in the growing seasons and to feed them to the cattle during times of shortage. Perennial grasses such as Elephant grass (*Pennisetum purpureum*) and Guinea grass (*Panicum maximum*) produce a bulk of green material but do not fit in with a normal crop rotation. Some of the annual grasses such as *Rottboellia exaltata* or *Sorghum arundinaceum* would fit in with the rotation but, initially, special efforts would be necessary in order to collect the seed. Later, a species such as *Rottboellia* might become a weed of the arable land by reason of its heavy seeding habit. The most suitable crops for silage would appear to be some of the crops already in cultivation which produce large quantities of green material. These include maize, sorghum, sunflower and various varieties of bean. For silage these could be sown at a higher

than normal seed rate, either pure or preferably as a mixture of cereal and legume.

Silage has been made successfully for a number of years on some of the experimental stations in Uganda, the actual ensiling process presenting very little difficulty [5] and [6]. Cereals are usually cut at or just before the flowering stage, that is for sorghum after eight to ten weeks' growth. In some cases the crop has been chaffed before ensiling, at other times the crop has been placed whole in the silage clamp or pit. The aim has been to produce an acid light-brown silage of medium feeding quality. In some instances, however, particularly if the crop has wilted, a sweet dark-brown silage has been produced.

One of the salient virtues of silage is the ease of stock-rationing. The crop is usually ensiled before the onset of the dry season. It is then a simple matter to calculate the quantity of silage made and to determine the maximum which can be fed to each animal each day throughout a set period of the year. Any surplus at the end of the season can be left for the following year without much chance of deterioration. This ease of rationing is in direct contrast to the feeding of sweet potatoes, when the ration per day has often to be varied to meet deficiencies and excesses in the crop of tubers.

A silage crop should be relatively easy to introduce into a rotation. By reason of the short period between planting and harvesting, the crop could be grown as a catch crop. On the other hand, the silage crop could directly replace some of the sweet potatoes in the standard rotation. Alternatively, some of the cereal normally grown for grain could be harvested earlier for silage. Whichever plan is adopted it is highly probable that the crop cut for silage would be the last crop before a resting period. Until the practice of silage-making is adopted the undersowing of a sorghum grain crop with *Chloris gayana* could be encouraged. The effect of the undersown *Chloris* on the yield of sorghum grain has not been measured, but the *Chloris* did not appear to suppress the growth of sorghum up to the silage stage. Consequently it is unlikely that the practice of undersowing would reduce the yield of grain harvested at a later date.

The introduction of this undersowing practice to some districts would be relatively easy. For example, in the Teso district sorghum is often planted after a cotton crop, only the minimum of cultivation, and in some cases no cultivation, taking place between the two crops, and provided there is some degree of tilth, *Chloris gayana* seed can be sown at the same time. The method depends upon the use of a seed with a high germination value, or alternatively of seed of a low germination potential sown at a high seed-rate per acre. Ten pounds per acre of 20 per cent germination seed, or its equivalent, would appear to be a minimum seed-rate. If Entebbe experiences are to be repeated in Teso and elsewhere in the Protectorate, grazing of the *Chloris* could be started shortly after the sorghum is harvested. Using this method the only extra cost entailed in the establishment of the ley is the cost of the seed. The advantages over seeding without a cover crop are that the ley is established quickly, and grazing can continue for the whole resting period; in addition the period of time that the soil is exposed to the elements is much reduced. Against these advantages must be weighed the possibility of the young grass seedlings being smothered by weeds if they are not sufficiently strong or sufficiently thick on the ground to withstand the competition, but if this occurred the only financial loss would be the cost of the grass seeds.

Finally, it should be emphasized that the undersowing of a sorghum silage crop with *Chloris gayana* has been successful in one year and in one paddock at Entebbe only. When opportunity arises the practice will be repeated on a large scale at Entebbe, but the method appears to be worthy of further trial elsewhere in East Africa. With increasing need for a sown ley on resting land and for additional supplementary feed for cattle the opportunity for applying this practice over wider areas will become more common.

ACKNOWLEDGMENTS

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NOTES ON ANIMAL DISEASES

XXVI—Rift Valley Fever or Enzootic Hepatitis

Compiled by the Department of Veterinary Services, Kenya

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This disease was first recognized in 1931 by the study of a disease of new-born lambs suffering heavy mortality in the Rift Valley of Kenya. Since that time it has been recognized in Japan, Uganda, the Union of South Africa and Southern Rhodesia, as well as elsewhere in Kenya. That it had occurred before appears to be definite, probably as early as an outbreak of disease investigated by Montgomery in 1912, but owing to the difficulty of differential diagnosis, especially with regard to conditions such as heartwater, it was not recognized as a specific entity until 1931.

Aetiology

The disease is caused by a filterable virus which affects sheep, cattle and goats. Human beings are also susceptible to natural infection.

Symptoms

The incubation period is extremely short, being about two to four days in natural cases, although experimentally the virus is present in considerable amount as little as 30 minutes after inoculation of mice. Humans suffer an influenzal type of disease, sometimes similar to malaria and showing transient fever, headache, pains in the back, bones and joints and in the abdomen, and at times interference with vision and sensitiveness to light. In animals the disease has been described as following four courses:—

The Per-acute.—This mainly affects lambs, shows 12 hours' incubation only, with death in about 36 hours in 95–100 per cent of cases.

The Acute Disease.—This affects lambs and occasionally adult sheep. The symptoms are: sudden rise of temperature, vomiting, mucopurulent discharge from the nose, unsteady gait, sometimes blood-stained diarrhoea, weakness and death. Surviving animals often abort.

The Sub-acute Disease.—This is common in adult sheep and in cattle. The features are: transient fever, inappetence, weakness. The milk rapidly diminishes. (All these symptoms occur also in three days' sickness.) Pregnant animals at any stage of pregnancy may abort and this may be the only sign in mild outbreaks. Mortality in cattle is usually under 10 per cent. Septic metritis may arise in ewes which have aborted.

The Mild or Inapparent Form.—In adult sheep or cattle there may be only slight febrile reaction. Diagnosis can only be made by laboratory examination of serum from suspected cases.

Post-mortem Picture

Rapid decomposition of the carcass is significant. The most characteristic lesions are those in the liver, which in early cases may show hæmorrhages or small white spots of focal necrosis under the capsule. A liver which is extensively involved is a rich golden-yellow colour. The cut surface has a rough appearance. Small hæmorrhages may be seen under the capsule of other organs such as the spleen and kidney, on the outer and inner lining membrane of the heart, and in the enlarged, soft lymphatic glands, especially of the mesenteric group. There is often severe gastro-enteritis, catarrhal inflammation and shedding of the lining mucosa. In severe cases it may give rise to such extensive hæmorrhages in the cæcum or blind gut that the contents appear tarry. There may even be perforation of the abomasum and cæcum.

Lesions in cattle are usually less definite than those in sheep. There may be confusion between Rift Valley fever and the following conditions: in sheep, bluetongue and enterotoxæmia; in cattle, with heartwater, hæmorrhagic septicæmia and other acute hæmorrhagic conditions, or with petechial fever. The aborted fœtus usually shows an œdematous hæmorrhagic condition of the tissues.

The typical outbreak is fairly easy to distinguish once well established, but diagnosis is otherwise based on one or other of the following methods:—

During the febrile reaction, blood may be drawn into O.C.G. mixture (obtainable from the District Veterinary Office) and sent to the laboratory for animal inoculation, though there may be difficulty in obtaining known susceptible large animals at short notice.

A blood sample from a recovered animal can be submitted for serological test.

From carcasses, a portion of liver in 10 per cent formalin should be sent for histological examination.

Diagnosis can also be made at the laboratory from a fresh aborted fœtus. When post-mortem examinations are made every precaution should be taken to avoid infection by inhalation or through small wounds in the skin.

Animals' Susceptibility

The natural disease affects sheep, goats, cattle and humans. The virus can be transmitted to mice, rabbits, cats and monkeys. The horse, pig and guinea-pig have proved insusceptible to inoculation, also the following birds: poultry, pigeon, parakeet and canary. There is a suggestion from South Africa, however, that migration of birds may have some bearing upon the appearance of the disease in that country in 1950.

Transmission

The virus is very small but can persist for a long time at ordinary temperatures in aborted material or post-mortem tissues. It is spread by mosquitoes and also directly, probably by inhalation among humans who may come into contact with the virus at post-mortem. Susceptible groups include farmers, herds, butchers, veterinary surgeons and laboratory workers. The disease is not contagious from indirect contact with sick animals, or, for example, nursing a human patient. Milk of infected cows contains virus.

It has also been found in wild mosquitoes which have successfully transmitted the infection and the latter can therefore be regarded as true vectors. In man, and possibly also in animals, sub-clinical infections apparently do arise and result in some degree of immunity. The virus has been adapted to mice brains and also to the chick embryo, both being used as sources of vaccine.

There is no specific treatment for the disease.

Recovered cases develop an immunity which is considered to be lifelong in humans and is probably of the same duration in stock, although this point has not been experimentally proved.

Preventive Inoculation

This consists of the use of vaccine obtainable from Kabete. The resulting immunity which follows eight to ten days after vaccination lasts for at least one year, probably for three or more years as the present vaccine is a live ovo-culture, i.e. a virus strain adapted to the chick embryo. The vaccine can be given to sheep or cattle of all ages except the newly born. As with any other vaccine, one or two individual cows or ewes late in pregnancy may show a temperature reaction which might give rise to abortion. This, of course, would be of no significance in the face of an outbreak, but should be borne in mind for annual vaccination. Mosquito control should assist and may take the form under practical conditions of moving animals to high ground during the wet season, although one recent outbreak started in the Rift Valley and spread right up the face of the escarpment to the plateau around Ol Joro Orok.

VEGETABLE TANNINS IN EAST AFRICA

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Vegetable tannins are usually considered as minor forest products. In East Africa, however, one of these, wattle bark tannin obtained from *Acacia mollissima,* has ceased to be a minor forest product and has an annual export value of over £1½ million. East Africa is the second-largest producer of this product, which is to-day the world's most widely used vegetable tanning material. The coastal mangrove swamps also yield a tan bark with exports of 3,500 tons per annum. Other tannin-bearing plants grow in East Africa, and Greenway [13] made an exhaustive list of them in 1941. He did not, however, record any experimental work other than reporting on the introduction of various exotic species. The purpose of the present article is to report some analyses of bark and fruit samples which have been obtained from plantations and forests in East Africa, and to mention species which might be exploited in East Africa for which there is a potential demand, either by the local tanning industry or for export to overseas centres of leather production.

At this stage it is thought that some useful purpose would be served by mentioning the types of tannins and the methods used in their analysis. The class of compounds collectively known as vegetable tannins may come from woods, barks, fruits, roots, or leaves of a wide variety of trees and shrubs. The tannin may be of two types, catechol or pyrogallol. Generally speaking, catechol tannins are obtained from barks or woods, whereas leaves and fruits yield a pyrogallol tannin. A simple method of identification is to note the colour of ink formed if an iron salt solution is added to an infusion tannin. Catechol tannins produce a green colour and pyrogallol tannins a violet one. Unfortunately this test is not absolute, and a more detailed laboratory examination is necessary to ensure correct classification.

In analysing any vegetable tannin material, internationally accepted methods are employed, which although empirical give reproducable results [1]. In carrying out an analysis a known amount of the material is leached with a known volume of water under prescribed conditions. The solid matter extracted is termed total extractives, whilst the solid matter left behind is classed as fibre. These two components plus the moisture content constitute 100 per cent of the original material. Whilst the extract is cooling, slight precipitation of insoluble matter occurs and this sediment is known as extracted insolubles. The matter still in solution is termed total solubles and contains components classed as tannins and non-tannins. Separation is carried out by a miniature tannage in which hide powder is shaken with the extract under standard conditions. The matter still in solution after this tannage is classed as non-tannins, and the matter combined with the hide powder is tannin. This paragraph may be summarized as follows:—

Moisture content of sample + total extractives + fibre = 100%

Total extractives = extracted insolubles + tannins + non-tannins

It should be emphasized that both the tannins and the non-tannins are not pure substances but mixtures of many chemical compounds. The non-tannins, although they do not actually combine with the hide or skin to make leather, affect the commercial process to a considerable extent. Amongst the more important components of the group are low molecular weight phenols, sugars, organic acids and numerous salts, all of which can modify the reaction between the tannin and the hide. They also affect the economics of both extract manufacture and tanning. Factors influencing the use of a particular tanning material are:—

(1) The amount of tannin present in a sample, 12.5–15 per cent is usually the lowest limit for economic exploitation.

(2) The ratio of tannins/non-tannins which must be greater than 1 to make satisfactory leather and greater than 2 to prepare a commercial extract.

(3) The ratio of total extractives which has an influence on the size of extraction plant to be used.

(4) The amount and composition of the non-tannins.

Frequently, in order to save shipping space, the tannin is extracted from the raw material near its source and the extract evaporated to

dryness. In Kenya, for instance, during 1953, 22,809 tons of wattle extract containing 60 per cent tannin were exported, compared to 855 tons of bark containing about 30–35 per cent tannin. To make factory extraction feasible an assured supply of raw materials is necessary which is more likely to come from plantations than indigenous forest. On the other hand, much smaller quantities of raw materials could be used by a small tannery extracting for its own requirements. Except, perhaps, when the tannin is a by-product of small importance, it is not enough merely to take into account the amount of tannin in a material; the yield per acre is also important. Factors controlling the latter, in the case of bark, are the volume of bark per tree, the closeness of planting and the number of years taken for the species to be ready for felling. When fruits are to be considered the weight of fruit obtained annually is important along with the fruiting life of the species. A further factor of economic rather than technical importance is the colour of the extract which is obtained. This is determined under specified conditions using the "Lovibond Tintometer" [1] and is expressed in terms of "red" and "yellow" units. Light-coloured leathers are demanded by many shoe manufacturers often at the expense of quality. In order to compete, therefore, a tanning material should have a low colour factor, particularly in the "reds". This criterion is more important in the United Kingdom than in the United States of America and explains the latter country's willingness to use the dark-coloured mangrove extract which has found little favour in Britain.

Although leathers can be made from only one type of tanning material, blending with either synthetic tannin or other vegetable materials is normally employed to obtain optimum quality. By this means the properties of the various materials are complementary to each other.

In the ensuing paragraphs only those materials which appear to have a distinct potential commercial value will be reviewed, although for the sake of completeness all results for materials examined by us have been recorded in Table I irrespective of their tannin content.

The Acacias

Although some species of *Acacia* are indigenous to Africa, those of most value as tanning mataerials are native to Australia. The black wattle, *Acacia mollissima,* is the most important source of vegetable tanning material in the world to-day. It has, however, a number of very closely related species particularly green wattle, *Acacia decurrens,* and silver wattle, *Acacia dealbata.* Green wattle has approximately the same tannin content as black wattle, but is inferior on two counts, deeper colour and thinner bark. Silver wattle has only half the tannin content of the other two species, and to prevent deception of the unwitting culture of this inferior species the Department of Agriculture in British East Africa enacted an Ordinance to prohibit the planting and sowing of silver wattle as long ago as 1912 [2]. The actual tannin contents of the wattles may vary quite considerably, variation being governed by the following factors: rainfall and soil moisture, [3] age of tree, position of sample in the tree (generally speaking there is more tannin in the bark at the foot of the trunk than at the top), season of stripping, and storage conditions. Black wattle may vary from 30–45 per cent tannin on air-dry weight (about 12.5 per cent moisture) although the average is more likely to lie between 35 and 39 per cent. Similar figures are to be expected from samples of green wattle, although the latter's colour content of "reds" is 50 per cent higher for comparative samples. Silver wattle samples, on the other hand, rarely attain 20 per cent of tannin, and the colour is still more affected by a high "reds" content. *Acacia pycnantha,* the golden wattle, is quite distinct from the black, green, and silver wattle, and can be distinguished by its broad leaves. Averaging 40 per cent tannin in the bark, it is one of the richest tan-barks known, and the colour is fairly good. The species will succeed in drier regions and on poorer soils than black wattle. Unfortunately, it is slow growing and the small size of the tree has till now precluded its large-scale cultivation as a tan bark, although the indigenous bark has been utilized in Australia.

Some indigenous Acacias have been examined. *Acacia seyal* from the Rau Forest, near Moshi, contained about 20 per cent of tannin and the bark was comparatively thick. Its very dark colour would tend to limit its commercial value, although a small proportion could quite likely be used in local tanneries. On the other hand, mixed samples of *Acacia albida* bark from the same forest contained only 2 per cent tannin, compared with 28 per cent recorded for the species by Greenway; the fruit, collected in September, yielded 14 per cent of tannin.

Acacia arabica grows in low-rainfall areas and is well known in many parts of Africa as a native tanning material. In N. India and Pakistan, the bark, known as Babul, is used to the extent of 100,000 tons per annum, it contains an average of 12 per cent tannin, which although uneconomical for factory production can be used in the cottage industries which produce much of India's leather. In Africa, however, it is the fruit of the tree, "sant pods", which have been most commonly used for tanning, not only in modern times for the production of Kano leather, exported from Nigeria to England, but also in ancient Egypt. This may be accounted for by the fact that whereas African deseeded pods contain about 30 per cent tannin, Indian ones contain 18–27 per cent. The variation is thought to be due to climatic conditions. Owing to a high non-tannin content the pods are unsuitable for extract manufacture, although they have been imported into Europe after crushing. Howes [14] considers that frequently fruits of other Acacias, e.g. *A. senegal* and *A. seyal*, have been marketed along with *A. arabica* as sant pods.

The Eucalypts

This is another important group which has been introduced into East Africa, originally for ornamental purposes, although in recent years plantations have been grown with various species in Kenya. There is a very wide variation between species in the tannin contents of the Eucalyptus barks. For instance, *Eucalyptus sideroxylon* frequently contains over 30 per cent of tannin, compared with only 2 per cent in *Eucalyptus globulus*.

Three species of Eucalypt have been commercially exploited for their tannin. *Eucalyptus astringens*, commonly known as mallet bark, was of limited distribution in Western Australia, where in the early years of this century it was exploited almost to extinction. Its high tannin content, over 40 per cent, along with ease of extraction, made it especially suitable for extract manufacture. Its few disadvantages were the very astringent nature of the tannin, which necessitated blending, and a tendency to darken on exposure to light.

E. astringens has been grown in both S. Africa and Morocco, and Greenway reports its introduction into Kenya and Tanganyika. Its potentiality would appear to have been overshadowed by the black wattle. A possible reason for this is that Eucalypts in general take rather longer to reach maturity than black wattle.

Eucalyptus redunca is used for the production of an extract known as Myrtan. Both the wood (8–13 per cent tannin) and the bark (13–21 per cent tannin) are extracted without separation. The colour is good and there is a considerable export industry in Australia. A disadvantage is the tendency for the dissolved extract to form insoluble sludge during tanning. About 30–35 tons of raw material suitable for extract manufacture are obtainable per acre.

A Eucalypt of particular interest in East Africa is the red ironbark, *Eucalyptus sideroxylon*. Although some reports have criticized the tannin from this species on account of its colour and insolubility there is little doubt that its use will extend in future years. Plantations have been established in Kenya, and barks from a number of samples all show that over 30 per cent of tannin is present in a much larger proportion of the bark than in the case of black wattle. The tannin is extremely astringent and would require blending before it could be used commercially. A preliminary survey has indicated that a yield per acre per annum of 1.8 tons bark might be expected in East African plantations. A French school has investigated the modification of *E. sideroxylon* tannin to improve its colour and stability with a fair degree of success. Tanning trials carried out by the present writers indicate that, blended with pine bark extracts, a leather of reasonable colour can be produced from *E. Sideroxylon* extract.

The exudation of a kino is characteristic of many Eucalyptus species. It appears in cavities in the bark, appearing on the surface and also penetrating right through to the timber. Initially almost colourless, the kino tends to form a resinous product on exposure to the air. Three samples of kino have been examined from East Africa Eucalypts, namely:—

E. drepanophylla(?) 80 per cent tannin on a 12 per cent moisture content.

E. paniculata(?) 78 per cent tannin on a 12 per cent moisture content.

E. rostrata 76 per cent tannin on a 12 per cent moisture content.

The two former samples were obtained from old trees (approximately 40 years) at the Veterinary Department, Kabete, and have been

provisionally identified by Mr. Verdcourt of the E.A. Herbarium. It was noted that the kino tended to darken on exposure to air, although it retained its solubility. An experimental tannage using the kino from *E. drepanophylla*(?) produced a very light-coloured leather, and no insoluble matter was deposited during the tannage, but penetration of the hide was slow. It is probable that much of the tannin in *E. sideroxylon* is from kino and that the value of this species is limited by the production of kino which may be a pathological rather than a natural condition.

None of the other Eucalypts recorded in Table I yielded significant amounts of tannin.

The Pines

Greenway's list of East African tanning plants makes no mention of the pines, since the species was introduced after publication of his paper. The two species examined, *Pinus patula* and *Pinus radiata*, were both from 10–11-year-old plantations in the Elburgon district. The samples contained about 16 per cent of tannin on a dry bark basis, and were very yellow in colour. In addition the tannins were exceptionally mellow and had a high "buffer" index [4]*.

It is probable that they will be capable of development as a commercial proposition. An investigation by Anderson [5] in Australia has reported similar potentialities. Two other pines which have a fair amount of tannin in the bark are *Pinus longifolia* and *Pinus halepensis*, both of which have been established in parts of Africa.

Mangrove

In many ways mangrove bark is a unique tanning material. Its supply from many parts of the tropics is virtually inexhaustible, planting is not necessary, and it will grow in conditions of salinity which exclude the development of other trees. The term "mangrove" does not relate to a single species or even to a single genus and the following are represented amongst the East African mangroves: *Rhizophora, Ceriops, Bruquiera, Avicennia, Sonneratia, Heritiera* and *Xylocarpus*. Grant [6] records that the bark of *Rhizophora mucronata* (Kiswahili, *Mkaka*) is the easiest to strip and prepare for export; its tannin content is also amongst the highest, 30–40 per cent. Despite so many apparent advantages, mangrove has never come to the forefront as a tanning material. Reasons which may be put forward for this are the difficulty of collecting the bark from coastal swamps, the non-uniformity of the tannin between genera, which precludes indiscriminate felling if a product of consistent quality is to be obtained, and the dark-red colour of the extracted tannin solution.

Extracts of mangrove, called "cutch", are made in the East Indies for overseas export. It must be emphasized that there is no great technical difficulty in the use of mangrove tannin, and it is indeed used in some countries. The resistance of leather-buyers in Britain, and incidentally in East Africa, to using dark coloured sole leather is probably the main reason for it not having been used more extensively, particularly as much of the world supply lies within the Commonwealth. Research is being directed to finding out more about the coloured components of mangrove tannin with a view to their removal or bleaching. If a satisfactory process can be developed at a reasonable cost there is little doubt that the use of mangrove will develop rapidly, particularly as it can be grown in swamps which are unlikely to be of use for other commercial crops.

Tannin-containing Fruits

Apart from the sant pods obtained from *Acacia arabica*, the majority of important tanniferous fruits belong to the two genera *Caesalpinia* and *Terminalia*. Frequently high tannin contents are found in the ripe seed containing pods of *Caesalpinia* which have been exploited commercially, particularly in South America. Being pyrogallol tannins they are particularly useful for blending with the catechol tannins.

Caesalpinia

Caesalpinia coriaria, commonly known as "divi-divi", is the most important of this group. The mature pod is 2–3 in. long and contains two to four seeds of low tannin content. The pod itself, accounting for 90 per cent of the dry weight, contains 40–50 per cent of tannin and is usually exported in a crushed form. *C. coriaria* has been introduced to many

* Buffer index is a term used by Leather Chemists, and is the slope of the titration curve of a tannin solution between pH 3–5. A low buffer index indicates that the tannin is astringent, a high one that it is mellow. An average for wattle extract is 0.5. The very astringent *E. sideroxylon* has a B.I. of 0.1 compared with *P. patula* 1.5 and *P. radiata* 3.1. It is governed by the presence of organic acids and salts in the non-tannin fraction.

tropical countries, although only in India has it been developed to any great extent. Its growth in East Africa has been recorded, where it was found to thrive at the coast. Trees growing at higher altitudes gave only small yields of pods [7]. In India, trees planted 135 to the acre can yield 100 lb. of pods each, giving six tons of pods per acre per annum. As profitable quantities of pods are produced for 25 years or more it would seem that this species might be of value for further development in East Africa. Apparently, it has also been used as a shade tree for coffee in the Mysore district of India.

Caesalpinia brevifolia is another South American shrub yielding a commercially used tannin under the common name of "algarobilla". Indigenous to Chile, it does not appear to have been successful when grown in other parts of the world. Similar in many ways to "divi-divi" the tannin content is of the order 45–50 per cent. The average annual production is 2,500–3,000 tons and it has a rather specialized use in the tanning of fur and other valuable skins. Climatic conditions favouring its growth are stated to be moderate moisture from light rains and a deep soil. In its natural habitat it is both hardy and drought resistant; 4 in. of rain in winter have been suggested as sufficient for growth, but a dry summer is essential.

Caesalpinia spinosa is the shrub which produces a pod known to the tanning industry as "tara". Widely distributed in north-western South America it has been established elsewhere in the world. Reports of its introduction and successful growth in East Africa are contradictory. Unfortunately, the writers have been unable to secure known samples of *C. spinosa* pods from East Africa, but hope to be able to carry out a conclusive investigation at some future date.

Terminalia

The dried fruit of various *Terminalia*, principally *T. chebula*, is probably the second most important vegetable tanning material in use at the present time. Known as "myrabolans" to the trade, it is especially valuable on account of its light colour, weight-giving properties when used in sole-leather production, and an ability to ferment and produce acid from the naturally occurring sugars. The species has been introduced from India to East Africa on a very small scale. Ripe fruits from an estate at Himo belonging to The Moshi Trading Co., have been examined. They were found to have a lower tannin content (21 per cent) than the general run of Indian species, which contain 32 per cent, although variations from 12–49 per cent tannin have been reported. The species is drought resistant and will grow, in India, at elevations up to 5,000 ft. In wetter regions the trees are generally larger, and it is also fairly hardy against frost. There is no satisfactory record as to the yield of fruit, although 20 lb. per tree has been mentioned.

A species of the Combretaceæ, *Combretum zeyheri*, obtained from indigenous forest at Moshi, was found to contain 13 per cent of tannin.

Tannin-containing Leaves

"Sumacs" are the important group of tannins derived from the leaves of the various species of *Rhus*. It is an extremely valuable material used in preparing near-white leathers for fancy goods. The traditional source of sumac was the dried and ground leaf of *Rhus coriaria* found in Mediterranean regions, particularly Sicily. The tannin content of Sicilian sumac varies from 25–30 per cent and yields of up to 1,500 lb. per acre annually are expected. The plants become exhausted after about 15 years. It is generally found on poorer soils, the plants being set 2–3 ft. apart in a winter rainfall area with a hot, dry summer. Sumac is rarely marketed in the form of extracts but the leaves are used as a warm infusion by the tanner. Although not developed commercially outside the Mediterranean area, *Rhus coriaria* has been grown successfully in both Australia and South Africa.

In recent years, three sumacs have been investigated as a potential source of tannin in the United States of America. They are *Rhus copallina* (dwarf sumac), *Rhus glabra* (white sumac) and *Rhus typhina* (Staghorn sumac) with tannin contents of 32 per cent, 27 per cent, and 25 per cent respectively. Commercial trials with all these materials have been satisfactory. Apart from being a domestic source of tannin in the United States of America, its cultivation has been studied in relation to soil conservation programmes because of its shallow, spreading root systems [8, 9, 10].

Finally, mention should be made of the Indian or "Dhawa sumac" from the leaves and twigs of *Anogeissus latifolia*. Immature leaves are the most useful from a tanner's

point of view and contain 38 per cent of tannin compared with 32 per cent in the mature leaves. Special investigations have recorded 55 per cent tannin in prepared young leaves.

Tanners' Dock

Because of extensive investigations which have been carried out in recent years towards extracting a tannin from the tubers of *Rumex hymenosepalus* (Canaigre or Tanners' Dock), it is considered worthy of mention. Canaigre is being grown for its tannin in the dry south-west of the United States of America, where yields of 20 tons per acre of tubers are expected. Six tons of fresh tubers would yield about one ton of extract containing 60 per cent tannin. The tannin content varies rapidly with the season and with storage and drying after lifting. Although known for over a century to contain tannin it is only in recent years [11, 12] that special attention has been paid to canaigre. Technical difficulties in its extraction and availability of other sources of tannin led to its neglect until World War II. Since then a thorough investigation as to its economic utilization and cultivation in semi-arid areas has been carried out and it is likely that canaigre will become an important commercial source of tannin.

Conclusions

In this survey, two classes of tannins have been discussed; those which are already in East Africa and either are or can be exploited, and others which would appear worthy of further introduction in the territories. The former group are mainly barks, some of which are likely to be available in a few years' time from relatively large-scale plantations as a by-product. It is considered that due consideration should be given to the value of the minor forest products which might accrue when such stands are felled. On the other hand there is the class of material derived from fruits or leaves which depend for their place in world markets on low-cost collection, usually by a peasant type of population such as exists in East Africa. The introduction of some of these species, particularly if they were found to grow in the drier regions which at present are of negligible value for agricultural purposes, might prove in time to be a valuable addition to the economy of East Africa.

Although the number of tannin-bearing species actually examined is somewhat limited, the authors hope that interest will have been raised in this subject, and that at some future date more detailed reports relating specifically to East African conditions will be published in this Journal.

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TABLE I

SPECIES	% Tannins	% Non-Tannins	Extracted Insolubles	Fibre	Approx. Age	Origin
Acacia albida (bark)	2·0	5·6	0·3	80·1	Unknown	Moshi.
Acacia albida (fruit)	14·3	17·3	0·2	56·2	September	Moshi.
Acacia seyal (bark)	20·2	6·2	1·3	60·3	Unknown	Moshi.
Brachystegia spicæformis (bark)	11·2	8·8	0·4	67·6	Unknown	Kenya, Coast Prov.
Cassia siamea (bark)	2·0	11·3	0·5	74·2	Unknown	Moshi.
Combretum zeyheri (seed)	12·9	38·0	1·5	35·6	September	Moshi.
Combretum zeyheri (whole fruit)	17·8	8·1	0·0	62·1	September	Moshi.
Cupressus lusitanica (bark)	8·9	16·2	0·4	62·5	11 Years	Elburgon.
Eucalyptus drepanophylla (?) (kino)	81·4	6·6	0·0	0·0	40 Years	Kabete.
Eucalyptus globulus (bark)	2·1	9·5	0·5	75·9	11 Years	Elburgon.
Eucalyptus paniculata (?) (kino)	78·0	10·0	0·0	0·0	40 Years	Kabete.
Eucalyptus rostrata (bark)	7·4	5·8	0·0	74·8	Unknown	Karura.
Eucalyptus rostrata (kino)	76·7	10·3	1·0	0·0	Unknown	Karura.
Eucalyptus saligna (bark)	5·9	12·9	0·1	69·1	11 Years	Elburgon.
Eucalyptus sideroxylon (bark)	30·4	14·5	0·2	42·9	19 Years	Londiani.
Eucalyptus sideroxylon (kino)	59·4	26·5	2·1	0·0	8 Years	Eldoret.
Juniperus procera (bark)	3·5	6·4	0·3	77·8	Unknown	Elburgon.
Kigelia pinnata (fruit)	Nil	—	—	—	September	Moshi.
Pinus patula (bark)	14·2	3·8	0·3	69·7	12 Years	Elburgon.
Pinus radiata (bark)	14·1	6·6	0·2	67·1	12 Years	Elburgon.
Terminalia ohebula (fruit)	20·8	21·0	0·5	74·2	September	Himo

NOTES.—All results have been calculated to a basis of 12% moisture content.
Ages have been recorded wherever possible for bark and kino samples.
The month of collection has been recorded for fruit samples.

THE PHOSPHORUS STATUS OF CATTLE IN PART OF CENTRAL PROVINCE, KENYA

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This investigation was prompted by the low content of phosphorus found in grasses at Kabete, especially during the dry season when values down to 0.13 per cent P_2O_5 in the dry matter have been recorded. During the period March, 1950, to May, 1951, analyses on *Chloris gayana, Bothriochloa insculpta,* and *Brachiaria dictyoneura* showed that during the dry season the content decreases to below 0.2 per cent P_2O_5, and that only during the exceptionally heavy rains of April and May, 1951, were values in excess of 0.5 per cent P_2O_5 in the dry matter recorded.

The average of 48 samples of British cultivated pasture as quoted by Orr [1] was 0.75 per cent P_2O_5 while Marston [2] states that 0.8 per cent P_2O_5 in the dry matter is necessary for good health and production in cattle. These figures are supported by the work of Curran [3] who found symptoms of cattle aphosphorosis in ten counties in Eire, and in each case it was associated with pasture containing less than 0.5 per cent P_2O_5 in the dry matter. These figures are relevant to high-producing animals, especially dairy cows whose phosphorus requirements are high on account of the phosphorus output in milk. In dealing with the phosphorus requirements for growth Maynard [4] gives the figures of 0.87 per cent P_2O_5 in the dry matter at weaning, falling to 0.46 per cent at maturity. As the survey reported here was carried out on native cattle, a more relevant figure would be that of Du Toit [5], who calculated that 0.32 per cent P_2O_5 in the dry matter is necessary for normal growth and development. Of the three grasses studied only *Chloris gayana* showed an average of more than 0.32 per cent P_2O_5. In Table 1 figures quoted by Du Toit for phosphorus-deficient pastures in South Africa are compared with the results for Kabete pastures.

TABLE 1—PHOSPHORUS CONTENTS OF KENYA AND SOUTH AFRICAN PASTURES

	% P_2O_5 in Dry Matter	
	Summer	*Winter*
Grass Veld, South Africa	0.27–0.39	0.11–0.16
Kabete Grasses ..	0.40–0.60	0.13–0.20

During the dry season (winter), the phosphorus content of the Kabete pastures is almost as low as the South African veld, but is somewhat higher during the rainy season, though during the 1950 long rains which were not as heavy as those of 1951 the highest figure recorded was 0.49 per cent P_2O_5.

It was on this South African grass veld that phosphorus deficiency was found to be the cause of a disease which was a serious menace to the cattle industry. The first symptom of phosphorus deficiency is a depraved appetite or pica; and the lamsiekte of sheep and cattle in South Africa and the loin disease of cattle in Texas are caused by a toxin contained in putrid material, especially bones, consumed by the animals in an effort to satisfy the obscure craving. The pica is accompanied by, or closely followed by a marked loss of appetite, and as the deficiency develops the animals become emaciated and have a generally unthrifty appearance. Other effects include weak bones, stiff joints, depressed milk yield, failure of cows to come on heat normally, and small calf crops.

Pica in cattle in East Africa is widespread but is mostly manifested in earth-eating or geophagia. French [6] made a study of salt licks and edible earths in Tanganyika and [7] collated the results of workers in Kenya and other parts of Africa. None of the samples had a high content of phosphorus and could not have supplied enough to supplement a diet deficient in this element. Sporadic cases of bone chewing by cattle have been reported in Kenya but the habit has never become widespread as it was in South Africa in the second decade of this century.

During work on aphosphorosis in South Africa, it was shown that the amount of inorganic phosphorus in the blood of cattle and sheep could be used in the diagnosis of phosphorus deficiency. The blood of animals receiving adequate supplies of phosphorus contained 5 mg. phosphorus per 100 ml. blood, whereas that of animals showing clinical symptoms of aphosphorosis contained about one-quarter of this amount. The blood content of inorganic phosphorus was therefore used in this survey as a criterion of the adequacy of the phosphorus nutrition of native stock.

Layout and Scope of Survey

The survey was confined to African-owned stock in order to avoid complications which would be introduced if mineral supplements were fed. As African stock-owners rarely supply mineral mixtures to their stock the level of inorganic phosphorus in the blood could be considered to give a reasonable indication of the phosphorus supplied by the pasture, and, therefore, of its content in the soil. The survey was carried out during the dry season, when the pasture is lowest in phosphorus, and any deficiency would be most likely to show.

The area covered by the survey lies in the Kikuyu reserve area north of Nairobi, and blood samples were collected from Kabete, Fort Hall, and Nyeri. Two hundred and two samples were collected from individual animals, and the inorganic phosphorus content estimated colorimetrically.

Results

The results of the analyses are summarized in Table 2.

Table 2.—Blood Inorganic Phosphorus Contents of Native Stock

District	Location	Number Tested	Average mg. per 100 ml.	Distribution			
				>5mg.	4–5mg.	3–4mg.	<3mg.
Kikuyu	Riruta ..	19	4·92	11	7	1	0
	Dagoretti ..	14	5·10	7	4	3	0
	Mayhai ..	10	4·38	2	6	1	1
	Gitangu ..	29	4·64	7	19	3	0
Limuru	Manguu ..	20	4·17	3	10	5	2
	Murithu ..	12	4·38	2	6	4	0
Fort Hall ..	Kawaharura ..	35	4·40	7	16	11	1
	Matuto ..	16	5·13	8	6	2	0
	Gitugi ..	6	4·86	1	4	1	0
Nyeri	Githere ..	28	4·30	4	13	10	1
	Githi	13	4·01	0	8	4	1

None of the samples tested contained less than 2 mg. phosphorus per 100 ml, so that clinical symptoms of aphosphorosis, such as were common in South Africa, were not expected. However, 25 per cent of the samples tested contained less than 4 mg. per 100 ml, and must be considered as sub-normal.

As the survey proceeded it became obvious that the animals with the lowest blood phosphorus were not those in poorest condition —in fact, quite the opposite. For instance, in the Riruta and Dagoretti areas, overstocking was so severe that grazing was virtually non-existent, and the animals were in poor condition, yet the average blood phosphorus was normal and the majority of the animals had more than 5 mg. per 100 ml. blood. The Limuru area has a higher rainfall, and in consequence the grazing was more plentiful and the cattle were in good condition, yet the average blood phosphorus contents were below normal, and only 5 animals out of 32 gave normal values.

In the Nyeri area where the grazing was plentiful and the animals in good condition, records of sex were kept to see if there was any difference between the phosphorus levels of the two sexes. The results are set out in Table 3.

Table 3.—Blood Inorganic Phosphorus Contents of Male and Female Stock

Range	Number	
	Male	Female
Over 6 mg. per 100 ml. ..	1	0
5 mg.–6 mg. per 100 ml. ..	1	2
4 mg.–5 mg. per 100 ml. ..	2	19
3 mg.–4 mg. per 100 ml. ..	1	13
2 mg.–3 mg. per 100 ml. ..	0	2

Average—Males (5) .. 4·97 mg./100 ml.
Females (36) .. 4·08 mg./100 ml.
Males and Females 4·21

Though the number of males was naturally much smaller than the females, they had in general a higher blood phosphorus content. Whereas only two out of thirty-six females had normal values, two out of five males had and one of these was over 6 mg. per 100 ml. The average for the males was normal whereas that for the females was almost 20 per cent below normal.

Discussion

Though there is no evidence of clinical aphosphorosis, the fact that 25 per cent of the animals tested had sub-normal blood levels must be taken as indicative of a marginal phosphorus supply in the grazing and this conclusion is supported by the other observations made during the survey.

The anomaly of the animals in good condition having a lower blood phosphorus content than those in poor condition then becomes explicable if we take into consideration two important facts. The first is that though the blood inorganic phosphorus content is an important indicator of the state of phosphorus nutrition, the level represents a balance between opposing factors such as absorption and excretion, deposition and mobilization and normal levels do not necessarily mean that the state of bone nutrition is normal. The second is that the requirements of an animal, especially a female, for production are proportionately greater than the requirements for maintenance. The animals in poor condition were obviously on a maintenance, or sub-maintenance, diet, and though the phosphorus content of the grazing in its dried-up state was at its lowest, yet the supply was sufficient for their lower requirements and the blood phosphorus levels were normal. On the other hand, the animals on good pasture were obtaining adequate amounts of Starch Equivalent and Protein Equivalent for maintenance with a surplus for production but the phosphorus supply was not adequate to meet the extra demand and this is reflected in the lower average blood phosphorus values.

On the assumption of a marginal phosphorus supply, the difference in blood phosphorus levels between males and females is also explicable when we consider the difference between the phosphorus requirements of males and females for production. The production ration of a female must be adequate for reproduction and lactation and, in view of the amounts of phosphorus in the skeleton of the fœtus and in milk, the demands for this element are heavy and, if not met, will lead to depletion of the mother's skeleton. The production ration of a male animal, on the other hand, has to supply the phosphorus required for a liveweight gain, which, being mostly muscle and fatty tissues with little or no skeletal development, is much more modest in its demands for this element. Thus it would seem that in the Nyeri district the supply of phosphorus in the grazing was adequate for the males but fell short of that required for female production and the deficit is reflected in their sub-normal blood phosphorus levels.

These results, both of pasture and blood analyses, therefore indicate that provision must be made for the extra phosphorus requirements, especially of breeding herds in any attempt to increase production in this area.

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(Vol. XX, No. 1)

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